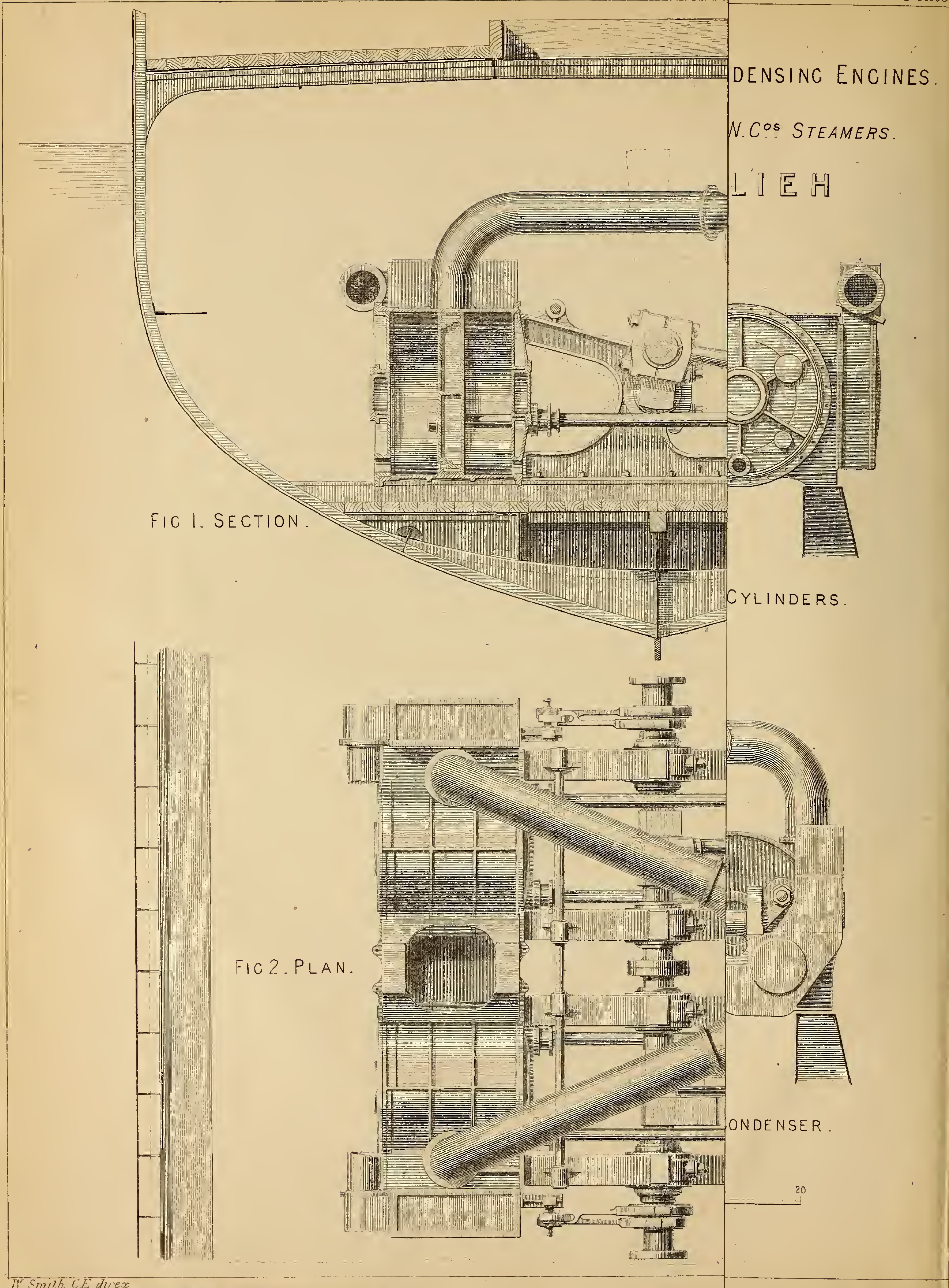

W. Smith C.E. direx

3

THE ARTIZAN:

A Monthly Record of the Progress

OF

CIVIL AND MECHANICAL ENGINEERING,

SHIPBUILDING, STEAM NAVIGATION, THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS, &c.

EDITED BY Wm. SMITH, C.E.,

F.G.S., F.C.S., F.R.G.S., &c.

VOL. IV.
THIRD SERIES.

VOL. XXIV.
FROM THE COMMENCEMENT.

London:

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19, SALISBURY STREET, STRAND, W.C.

1866.

350. HP Double-Piston-Rod, Expansive and Surface Condensing Engines.

Constructed by Messrs J. and G. Rennie for the P&O. S. N. Cos Steamers.

CHARKIEH AND DAKAHLIEH

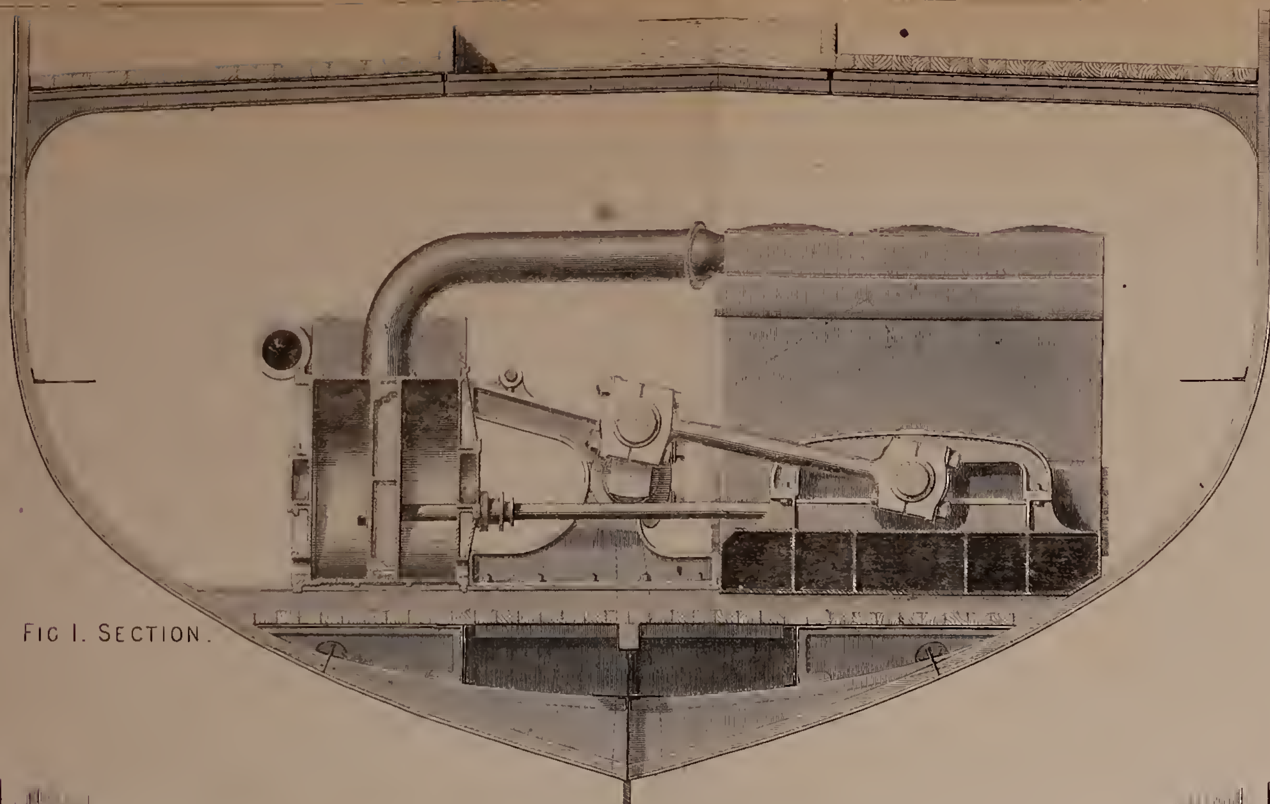

Fig 1. Section.

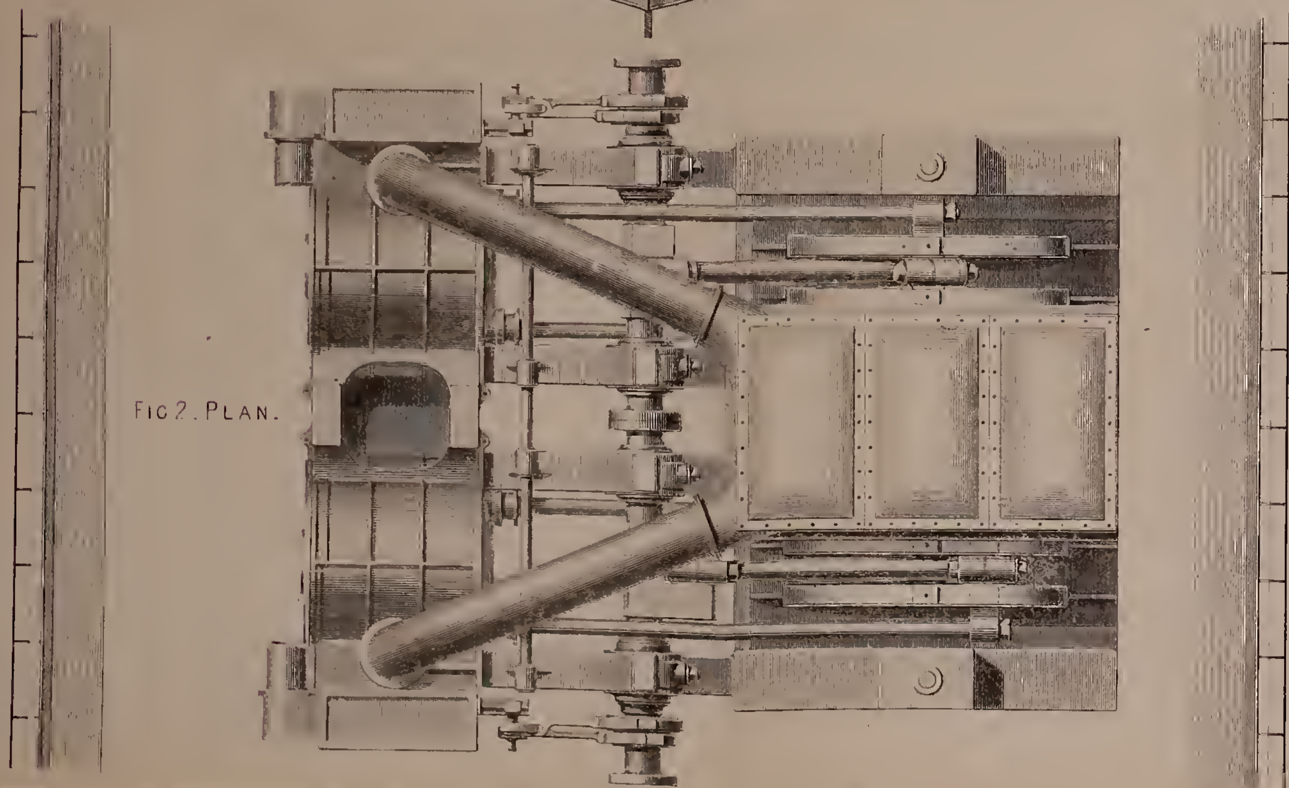

Fig 2. Plan.

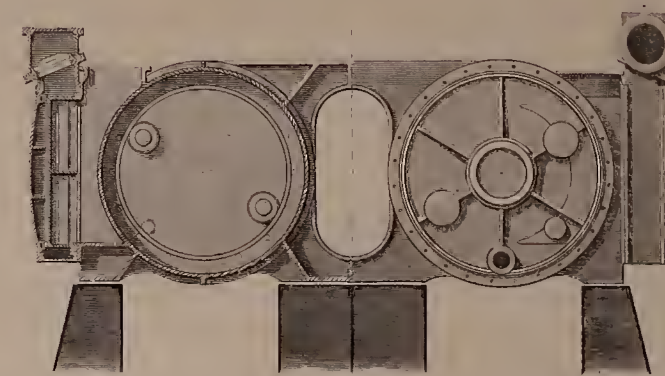

Fig 3. End View. and Section of Cylinders.

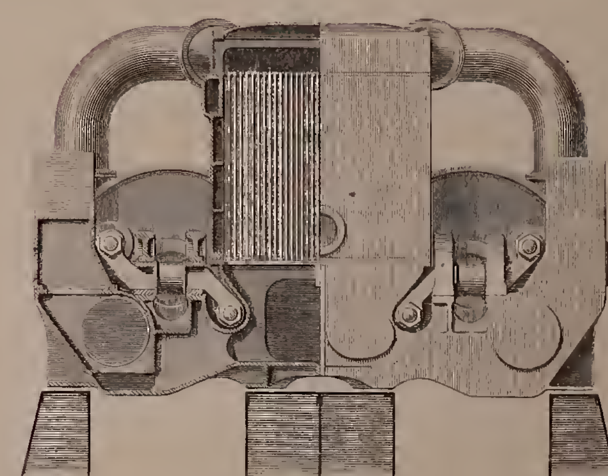

Fig 4. End View. and Section of Condenser.

Scale of Feet

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6342-73

INDEX TO VOL XXIV.

THE ARTIZAN JOURNAL, 1866.

LIST OF PLATES.

TO THE BINDER.

Plate 305. Engines of the Steamers *Charkieh* and *Dakalieh* to face Title-page.

PATENT DUPLEX PLANING MACHINE

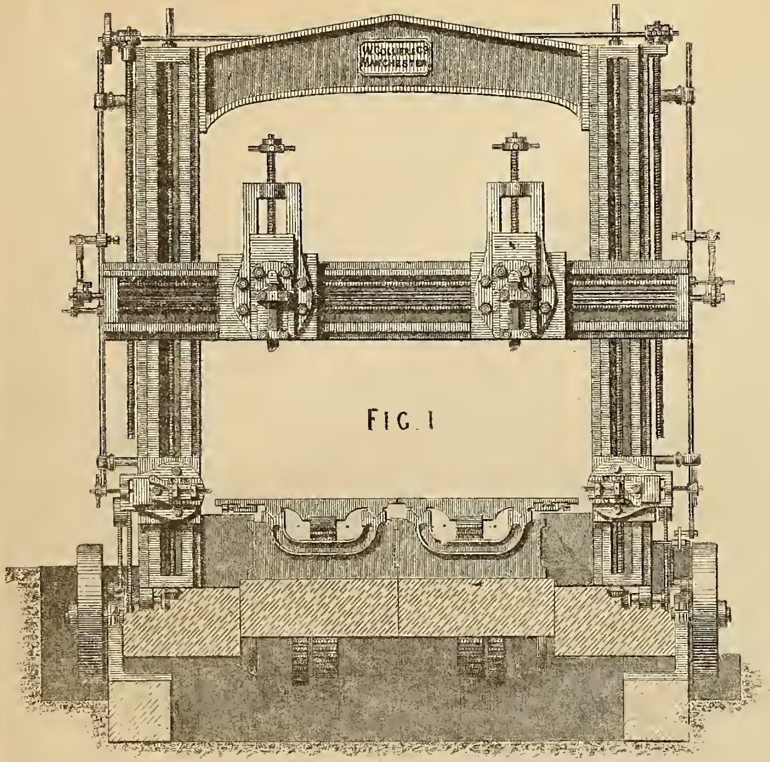


FIG. 1

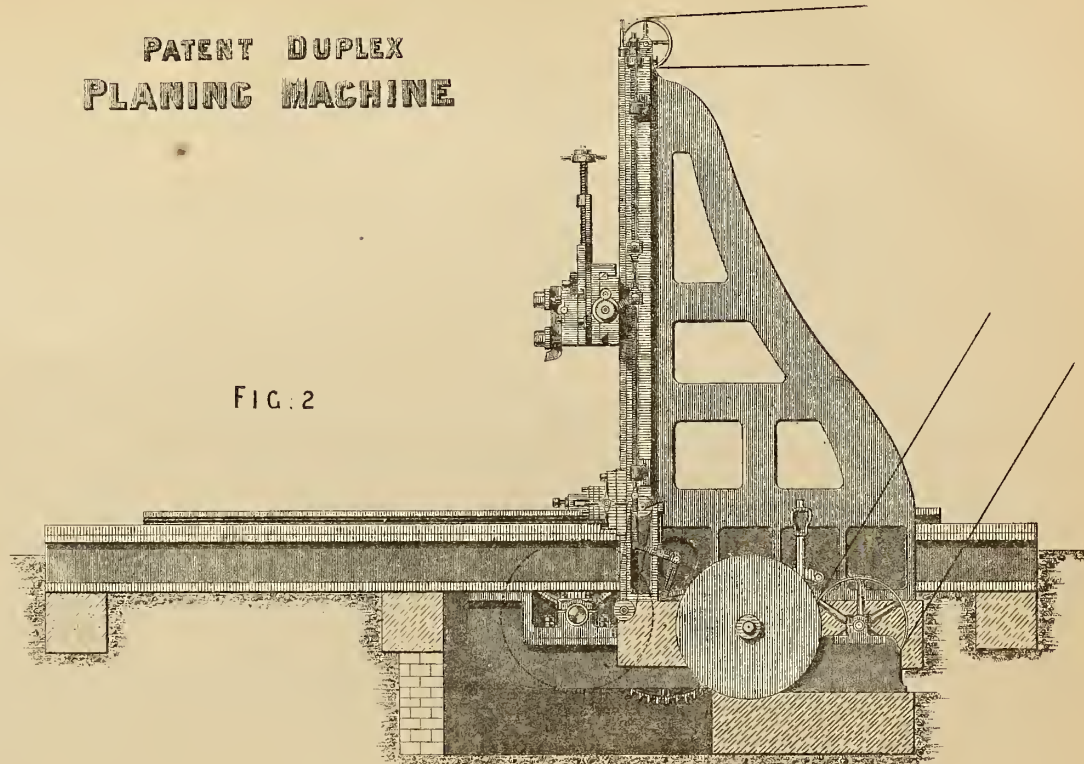


FIG. 2

12 6 0 1 2 3 4 5 10 15 20 Feet

Scale of Feet

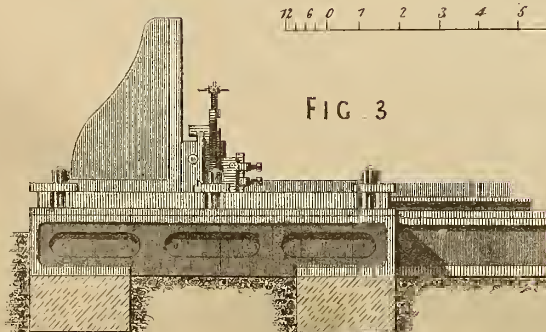


FIG. 3

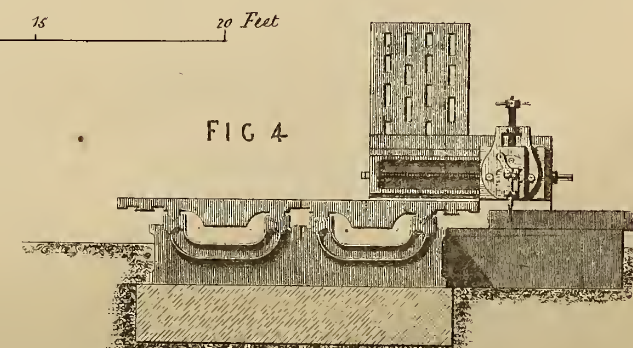
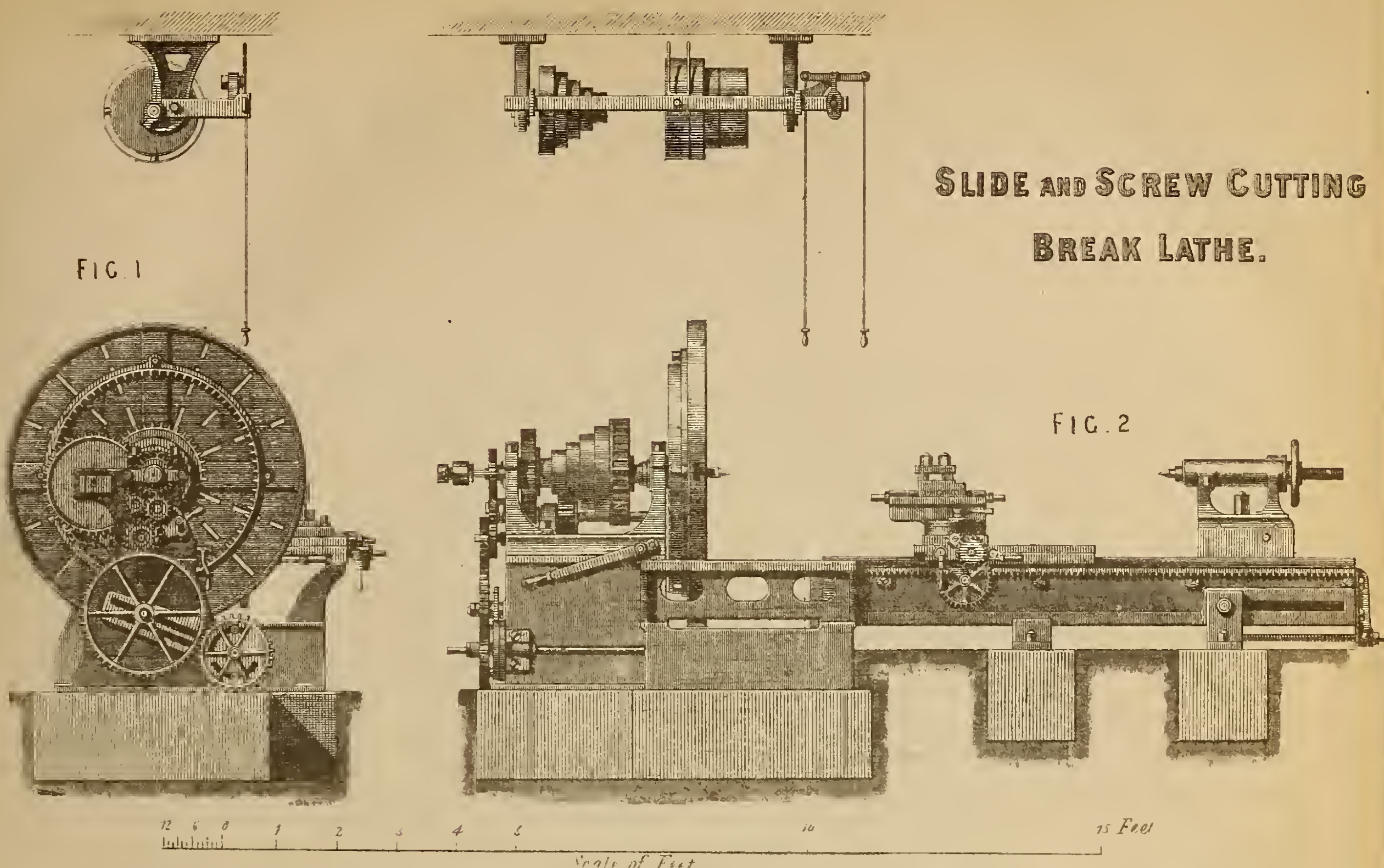
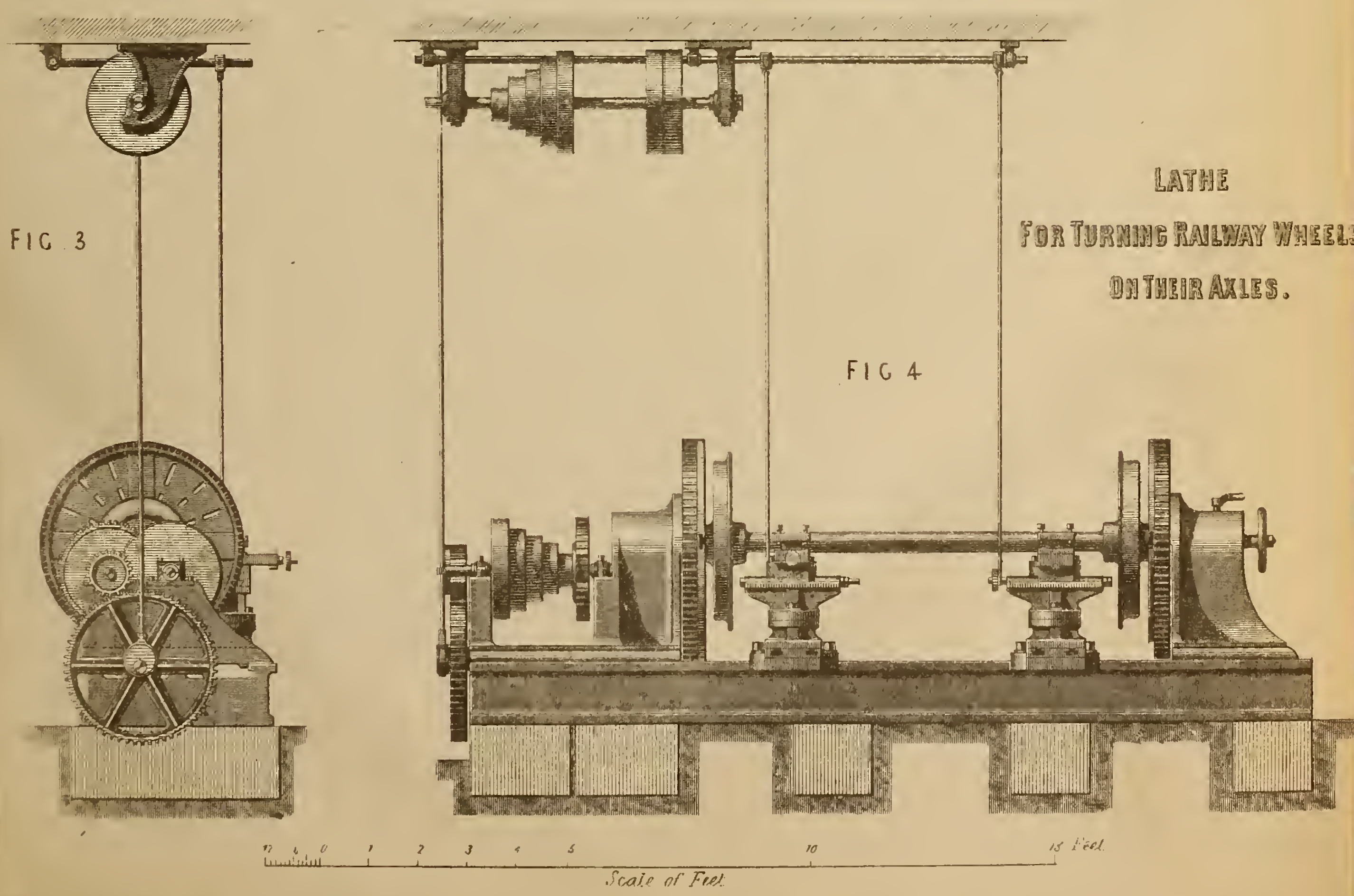


FIG. 4

SLIDE AND SCREW CUTTING BREAK LATHE.



LATHE FOR TURNING RAILWAY WHEELS ON THEIR AXLES.



W Smith, C E direx.

THE ARTIZAN.

No. 37.—Vol. 4.—Third Series.

JANUARY 1st, 1866.

WORKSHOP MACHINERY.

Patent Duplex Planing Machine.—Slide and Screw Cutting Break Lathe and Lathe for Turning Railway Wheels.

(*Illustrated by Plates* 293 *and* 294.)

The introduction of the planing machine and its subsequent development has effected an entire change in the manufacture of tools and machinery of every class, giving the means of carrying out with facility many works which had been left unattempted previously as too expensive or impracticable, and opening the way for improvements and invention generally; and in a short time these machines became indispensable in every workshop. The slide lathe became then comparatively easy of manufacture, and in conjunction with the planing machine and self-acting drill formed a most important feature in the advancement of engineering work. Still much remained to be effected: a large proportion of work was done by hand, especially the smaller portions of machinery, until slotting and shaping machines were brought into use, and special tools adapted for all parts where a quantity of work was required to be produced. By the gradual introduction and perfecting of the regulator screw, the wheel cutting engine, standard gauges, large surface plates, long straight edges, and scraped surfaces, combined with the improved tools, not only was the amount of manual labour considerably diminished, but the work was done more expeditiously, and a much greater degree of accuracy was attained, whereby the workmanship in all classes of machinery was remarkably improved and at a great reduction in cost. As engineering skill has been recently brought to bear on schemes which could not previously have been carried out, so tools have been enlarged and new ones invented to meet the exigencies of new works, until engineers and others became really dependent for the accuracy and execution of their work upon the tools that could be employed for the purpose.

In Plate 293, fig. 1 represents a front view, and fig. 2 a side elevation of one of Messrs. Collier's patent duplex planing machines.

In the first planing machines the table was moved by means of a chain winding on a drum as in the old hand machines. But this mode was found to be very objectionable; the cut was unsteady, and when the tool was suddenly relieved at the end of its cut, the table had a tendency to spring forward; it was also driven at the same speed both forwards and backwards, and thus a great loss of time was occasioned. This was much improved upon by the use of a rack and pinion, arranged to give a quick return motion, and also afterwards by the screw arrangement. Much difference of opinion had existed as to the relative value of the rack and the screw for driving the tables of planing machines. We shall not, therefore, go into this question further than to state that we are of opinion that the rack is decidedly the most preferable mode of driving.

In some of the earliest planing machines the Vs were made inverted, evidently with the idea of preventing any cuttings that fell upon the wearing surfaces from remaining upon them. They proved however to possess no advantage even in this particular, as the finer portions of the cuttings still adhered; and in addition it was found that from the motion of the table the oil by its own gravity would not remain upon the surfaces, and thus caused them to cut and wear away quickly. They were afterwards made an ordinary V shape and found to answer much better, as the V formed a reservoir to contain the oil in a groove at the bottom, from which it was raised at each stroke by the motion of the table and the apparatus attached for that purpose. The Vs have been constructed of different angles and widths of surface; but it is our opinion that at the present time many machines are made with the angle too obtuse, and the surfaces widened to too great an extent. In machines with very shallows Vs, taking a heavy cut off a light article with the tools on the uprights, the table is liable to shift sideways, causing the tools to dig into the work and occasion much mischief. Also with very wide Vs the table when making short strokes cannot work the oil up to the top of their surfaces, and thus allows them to cut or gall.

The planing machines were further improved by the use of two toolboxes on the cross slide, and by the application of slide rests or toolboxes fixed upon the uprights, self-acting vertically, for planing articles at right angles to the tools on the cross slide. The reversing tool box is a very ingenious and useful contrivance for planing flat surfaces; but that plan is not so well adapted for general purposes. Planing machines have like other tools been specially adapted to a great variety of work, and they have been made with different numbers of tools up to as many as sixteen, all of which were in operation at once.

The great changes which have lately taken place in the manufacture of wrought iron and steel ordnance, and the revolution they have caused in the construction of vessels of war, have called into requisition a great many alterations and adaptations of the ordinary machines, as well as many entirely new ones. The planing machine especially has been called upon to do work of a very curious and intricate character, namely that of planing the edges of armour plates to different curves, shapes, or angles. In most cases this has been accomplished by a pattern bar of iron or steel, placed on edge in a small chuck fixed upon the surface of the table, adjustable by set screws, and shaped to the form to which it is required to plane the edge of the plate; as the table travels, this bar, which runs between two circular rollers attached to the underside of the tool slide, moves the tool sideways according to the amount of curve in the shaper or guide bar, the tool box being disconnected for this purpose from the screw in the cross slide.

The Duplex Planing Machine is arranged with double beds and double tables, each table having a separate set of gearing, with stopping, starting, and feed motions. There are, as shown, two tool boxes on the cross slide, each of which is independently self acting, so as to work with its own table. Thus the two tables may be used separately as two smaller machines working independently of each other, and capable of planing different lengths of work at the same time; or when planing a large piece of work the two tables may be coupled so as to act as one large machine. Also, one table may be fixed stationary as a bed plate to bolt awkwardly shaped or long pieces of work upon, whilst they are planed by a slide rest fixed upon the other table.

By having a stationary table fixed at one side of the bed, and an angle bracket and slide upon one of the moving tables, the capabilities of the machine are still further enlarged. This arrangement is shown in side elevation in fig. 3, and in front elevation in fig. 4.

In the earlier construction of the lathe the slide rest was the first great step towards the principle of the slide lathe, and no doubt led to that invention, which was considered impracticable before planing machines were made of sufficient magnitude to plane a lathe bed of even small dimensions. A few slide lathes had indeed been made, the beds of which

were composed of a timber framing, covered with iron plates on the upper side to preserve the surface, similar to those which were previously used for the ordinary hand lathes, with the exception that the outer edges of the iron plates were made of suitable shape to form the Vs for the carriage to slide upon. It was not, however, until some time after the introduction of the planing machine that, the cost of workmanship being considerably lessened, slide lathes came into general use and their utility was fully acknowledged and attention directed to their improvement.

The application of a screw to the slide lathe, so as to render it capable of both sliding and screw cutting, was the next important improvement; and a great amount of time, perseverance, and capital was expended by a few persons in endeavouring to perfect this portion of the lathe. A short screw was first made as accurately as possible, with the rude means then possessed, from which one was cut double the length, by changing the turned bar end for end in the lathe after cutting one half. Subsequently by following out this principle screws were capable of being made of any length required.

After this the surfacing motion was introduced; and also the use of a shaft at the back of the lathe, in addition to the regulator screw for driving the sliding motion by rack and pinion, instead of both the motions of sliding and screw cutting being worked by the screw alone. For it was found that the threads of that portion of the screw nearest the fast headstock being most in use, were worn thinner than the other parts; and in consequence the lathe did not cut a long screw with the degree of accuracy which it otherwise would have done.

Thus step by step improvements were gradually brought forward; the four-jaw and universal chucks and other important appliances were added, so as to render the lathe applicable to a great variety of work, even cutting spiral grooves in shafts, scrolls in a face plate, skew wheels, and also turning articles of oval, spherical, or other forms. The duplex lathe, with one tool acting in front and the other behind the work, is also found to be a very useful arrangement for sliding long shafts, cast iron rollers, cylinders, and a great variety of work where a quantity of the same kind and dimensions has to be turned.

In Plate 294, fig. 1 represents an end elevation, fig. 2 a side elevation of a slide and screw cutting lathe by Messrs. Collier, and figs. 3 and 4 similarly represent a lathe for turning railway wheels on their axles, also manufactured by the same. This lathe, it will be observed, is fitted with two slide rests, so that both wheels of a pair may be turned simultaneously, whereby a saving of time is effected.

DETAILS OF WATERWORKS.

(*Illustrated by Plate* 292. *Continued from page* 269, *vol.* 3).

Appendix.

Plate 292 shows the works executed to collect the various springs from which the Scarborough Waterworks are supplied. The springs issue from the surface of the cliff, the soil consisting of disentigrated oolite overlaid by Oxford clay. The system followed was this: the springs being found, the water yielded by them was conveyed temporarily to the old mill dam through pipes and wooden troughs shown by the dotted lines. Subsequently the ground through which the springs burst was made good, large stones being embedded in the clay wherewith the banks were made, to form an artificial rock through which the water yielded by the springs might flow.

The cliff was formed into benches with intermediate slopes, some of which are shown in the plan, all of them being shown in the section.

In Fig. 1 A shows the accumulations of stones at the outlet from the rock of the upper spring—B is the trough through which a portion of the water was temporarily passed, the remainder flowing through a timber trough C I which was subsequently filled up with stones; the supply from the spring E being brought into the channel C I through the chain of stones shown in the plate.

The well H is supplied through the pipe D from the springs A and F, and also by the stone drain, shown on the plan.

T L shows the position of a pipe carrying the greater part of the water from the spring A, to the permanent culvert N, into which the yield of the lower spring M is also brought, the culvert being terminated by the well *o*; O P shows the pipe through which the water gathered in the well *o* is conveyed to the well Q whence it passed into the new reservoir into which also flow the smaller streams from the well H and the drain S being collected in the cesspool R.

Fig. 2 is a section of the cliff along the line of main from the new engine house to the cock house.

(*To be continued.*)

STEAM CULTIVATION.

Since the utility of the steam plough was first established the number of rival manufacturers of agricultural machinery has greatly increased, and now steam power is becoming as common a servant on the farm as in the factory.

Those who have devoted their time to promoting the extended application of steam power to agricultural purposes have had to contend with peculiar difficulties. The machinery had to be introduced amongst a population entirely unused to anything of the kind, and the inventors could scarcely gain the amount of assistance in the way of advice usually to be obtained from those who purpose employing machinery; and it must be admitted that the only way to arrive expeditiously at a satisfactory result in such a case is by thorough co-operation between the inventor or designer of any proposed apparatus and the intending employer; otherwise the former must expend much time in getting a knowledge of minute details of working with which he might otherwise be at once made acquainted by the agriculturalist. This concatenation of difficulties will in a great measure account for the comparatively slow progress of agricultural engineering, and the imperfect and unsatisfactory condition of many kinds of implements.

Thus in the early reaping machines some inconvenience accrued from the bruising of the heads of corn by the apparatus which brought the corn to be cut into contact with the knives or cutters. The form of this portion of the machine was the same as that of a common paddle wheel with radial floats. The evil referred to would have been obviated by substituting *feathering* floats for the radial ones, as those entering edgeways between the rows of corn would not be so likely to injure it. Defects such as these have frequently prevented the general adoption of machines otherwise very excellent, and many, if not most of them, might have been avoided in the first instance by a due co-operation between the mechanic and the agriculturalist.

Numerous forms have been introduced for the portable engines which supply the power requisite for steam cultivation; but probably the most characteristic are those by Fowler, Savory, and Howard.

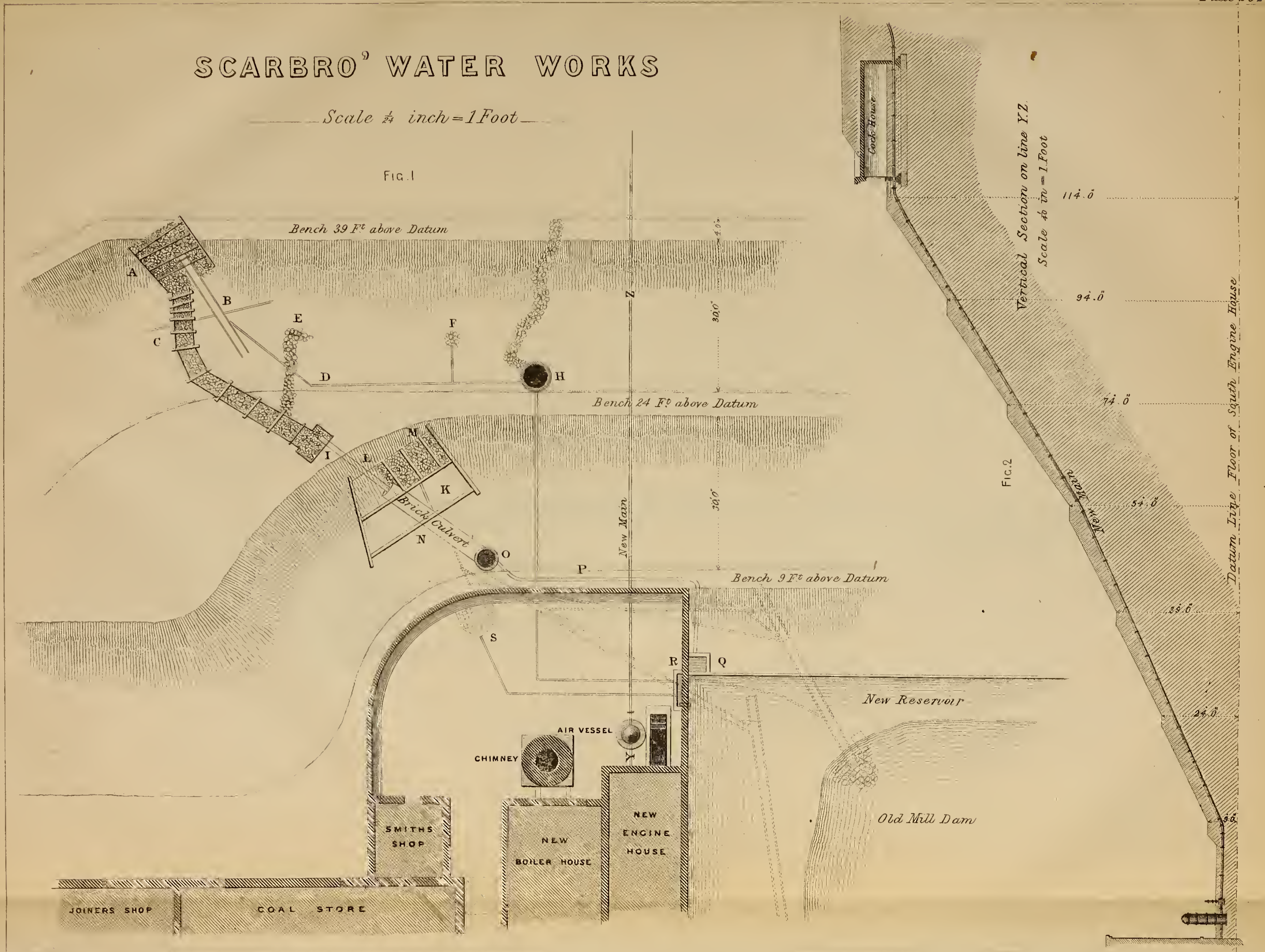
Fowler's engine carries its windlass under the boiler, which necessarily throws the latter unreasonably high and involves the use of a heavy class of framing, otherwise Fowler's system has proved very successful.

In Savory's patent steam cultivator, the drum or windlass is carried round the boiler, thus enabling a large drum to be employed without making the machine particularly cumbersome, and, in fact, taken as a whole, Savory's cultivator presents a tolerably compact appearance.

Howard's cultivator, on the other hand, is particularly bulky, the boiler being set transversely to the framing, with a view, we presume, to keeping the water level more uniform when ascending and descending inclines; but too many points of equal importance have been sacrificed to that one in the instance of which we are treating. The windlass is placed at the side of the boiler.

While treating of steam machinery used for agricultural purposes, it appears desirable to refer briefly to ordinary portable engines and road locomotives.

Of the former class it may be observed generally that there is not much difference in point of superiority amongst the engines constructed by various makers, which fact may be considered due to the general knowledge of the conditions necessary to be satisfied in order to produce a satisfactory result, while at the same time those difficulties which have militated against the success of road locomotives scarcely affect portable engines. In fact, the only evil which is common to both of them seems



W. Smith C.E. direx

to he that arising from irregnlar water level due to inequalities of the ground upon which the engine may he employed. In the manufacture of road locomotives considerahle difficulty has been found to arise from the gearing through which the power of the engine is transmitted to the driving wheels, hreakages being very frequent in the teeth of the wheels. In one instance it was attempted to ohviate this liahility to fracture hy adopting a form of spnr wheel, of which the following is a description:—

The spur wheel connected with the driving wheel was made in four or more segments connected together by strong helical springs, which it was anticipated would, hy yielding slightly, absorb the concussions due to inequalities of the road upon which the engine may happen to be travelling. Whether this engine has ever heen largely used we have not ascertained, hut presume that it was not found practically successful. Most of the traction engines hitherto constructed have presented a clnmsy appearance, the neatest and most compact prohahly heing that manufactured by Mr. Taylor, of Birkenhead, which, in our opinion, approaches very nearly to all that is required in a road locomotive.

PILE-DRIVING ENGINES.

In the working of any machine, wasteful expenditure of power is a serions drawhack to its efficiency and economic value. In the pile-driving engine, where the work is done by the blow produced through the fall of the monkey or ram from a given height, from which it had been raised, is of considerablo importance; but the freedom with which it is permitted to fall upon the head of the pile is of the chiefest consequence as affecting the amount of work done by the known weight falling through a given number of feet an ascertained number of times. Now that the use of the pile-engine has grown to such an enormous extent in this country consequent upon the extraordinary amount of public works in progress, the economy and efficiency of the working of snch machines has attracted attention, and Messrs. Eassie and Co., of Gloucester, and Great George-street, London, have succeeded in producing some very valuahle improvements in pile-driving engines, which we consider as well worthy of the immediate attention of engineers and contractors.

The chief mechanical improvement which has been effected is the suspending of the monkey or ram at or near its vertical axis (instead of from some point of attachment at or near the back of the monkey) hy means of the chain which is carried from the hack of the guides to the proper position in the front, to suspend the monkey or ram from the proper point, by passing throngh a carriage or follower, the use and action of which will he shortly explained.

The monkey has a hook or catch at its upper end, free to move to a limited extent, to enable it to take into the studs of the pitch chain, and to he disengaged therefrom when the proper height has been attained, and the strike-off catch comes into action; the superior termination of the hook being suitahly bevelled for the purpose, the monkey becomes disengaged from the projecting portion of the endless pitch chain, falls upon the head ef the pile, being guided in its descent by the upright slides or guides of the pile-engine, whilst the "follower" also falls, hut less quickly, leaving the monkey time to rehound, and then again brings the chain in contact with the hook into which it again takes or becomes attached, and the monkey is again raised until it reaches the strike-off catch, which may be regnlated to any height by means of the rack upon the face of the slides or nprights; and so the work is continued uninteruptedly, and the monkey is not only raised each time with the least possihle loss of power and with the least possible wear and tear of the machine, but also falls with the utmost nseful effect upon the pile head in the performance of its work, and it may be said to be as continuous and nearly as self-acting an apparatus as it is possible to obtain for such a pnrpose.

Within the monkey, and connected with the end of the hook hy which the monkey is connected to the chain, and is lifted, is a spring, so that at the moment of contact, instead of the sudden and injurious strain usually thrown upon the chain, or the hook, or on hoth, the monkey is picked up without any such jerk and consequent damage.

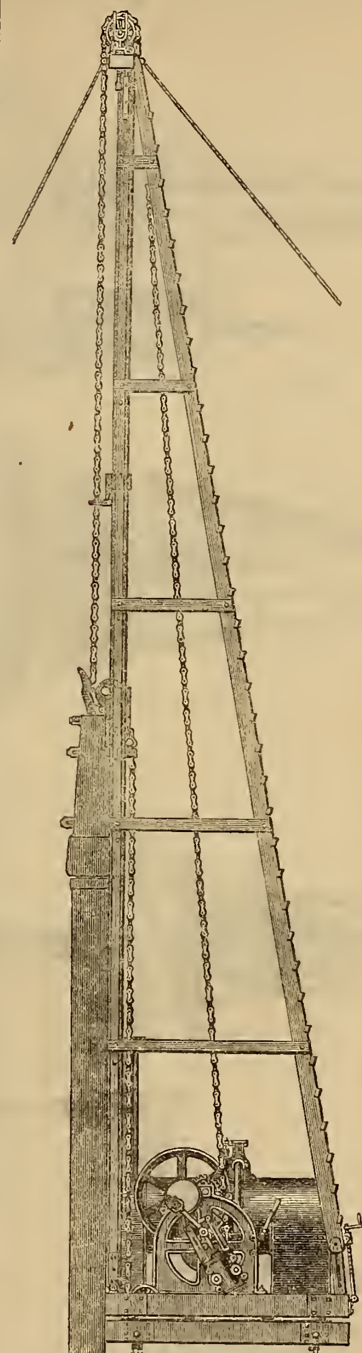


FIG. 1.

Messrs. Eassie and Co. have applied their novel arrangement not only to pile engines of the ordinary description of such apparatus, in the well-known type of pile engine shown in fig. 1, which shows in side elevation, an improved pile engine, and is so self-explanatory as to render unnecessary any further detail description of its parts; but they have also effected some very novel and useful improvements in pile engines as a whole, so as to adapt them to other classes of work, and under circumstances and in situations more difficult of application then heretofore. Figs. 2 and 3 illustrate Messrs. Eassie and Co.'s improved pile engine designed for driving piles below the level of the staging or platform npon which the pile engine is mounted and travels, and by the use of which the employment of the "needle" is superseded and the monkey is made to perform its duty direct upon the head of the pile to be driven. This is effected hy making the uprights or guide pieces of the pile engine sufficiently wide apart to receive between them the guide pieces (or guides proper) between which the monkey is caused to traverse up and down, and which is projected to the required extent below the level of the staging or traveller to commence and follow up the work as it progresses; when the work is done aud the position of the pile engine has to be changed, the guides are slid or hauled up within the frame of the pile engine, so as to clear any obstruction to its forward, backward or side motion. Figures 4 and 5 illustrate another important arrangement for pile-driving, embodying the original mechanical improvements effected in the details of pile driving engines with the general modifications and improvements last described for the purpose of driving piles, the heads of which, at the commencement of the work, being at more or less distance below the staging or platform. This last arrangement, as shown by figs. 4 and 5, is designed for driving two rows of piles hy the same engine, and in the illustrations the two rows of piles are inclined outwards or with an amount of batter, a most useful class of work, and this machine is a valuable addition to the mechanical means of e[illegible]ting it. The economy of keeping the power more uniformly and [illegible]uously employed, will be readily appreciated; the one monkey may be in course of elevation immediately after the other monkey has been released and detached from the chain and the follower.

These pile driving engines are really well designed mechanical contrivances and are capable of effecting most important economical results to contractors in the execution of extensive public works.

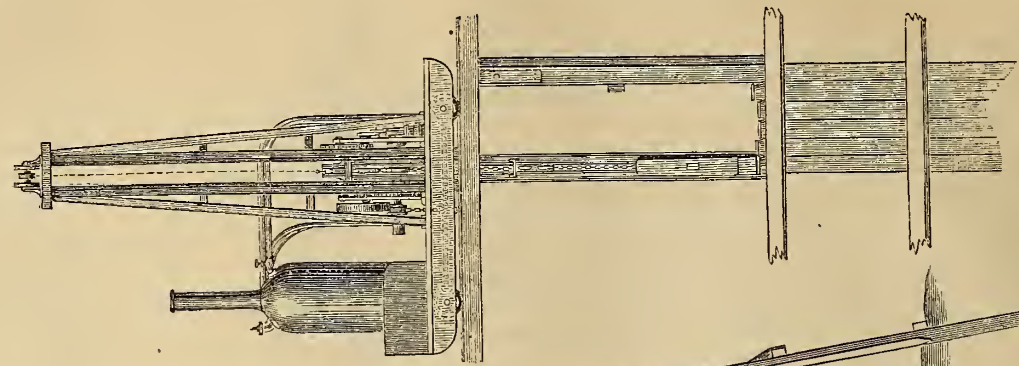


Fig. 5.

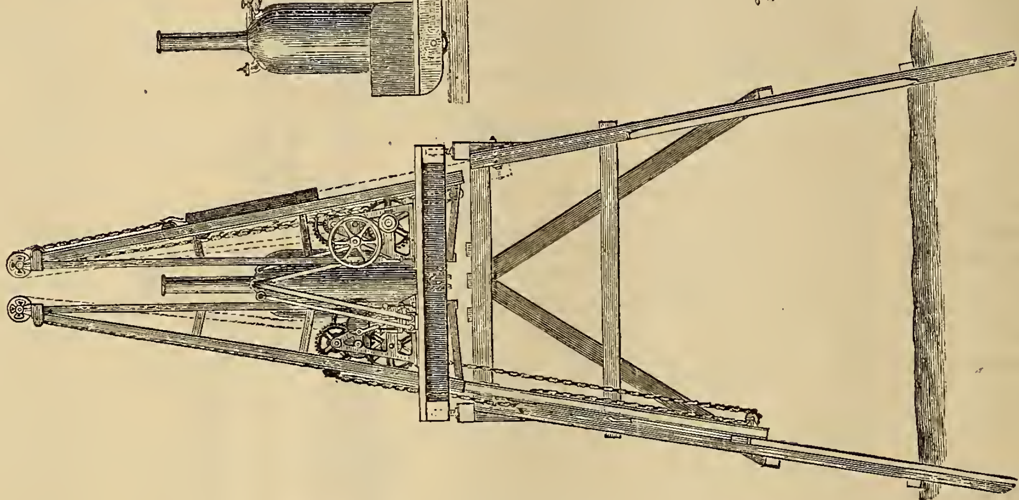


Fig. 4.

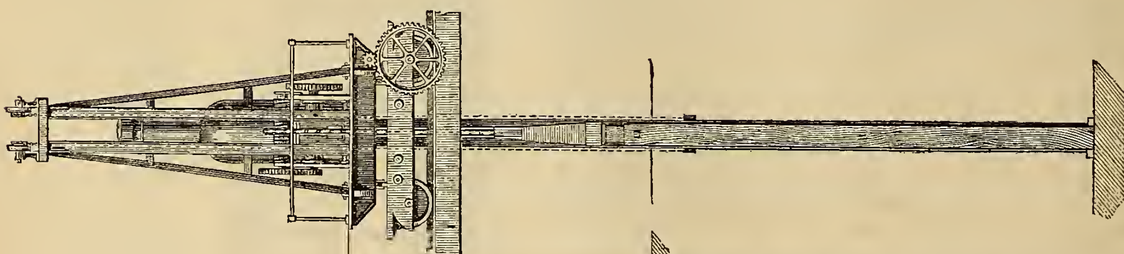


Fig. 3.

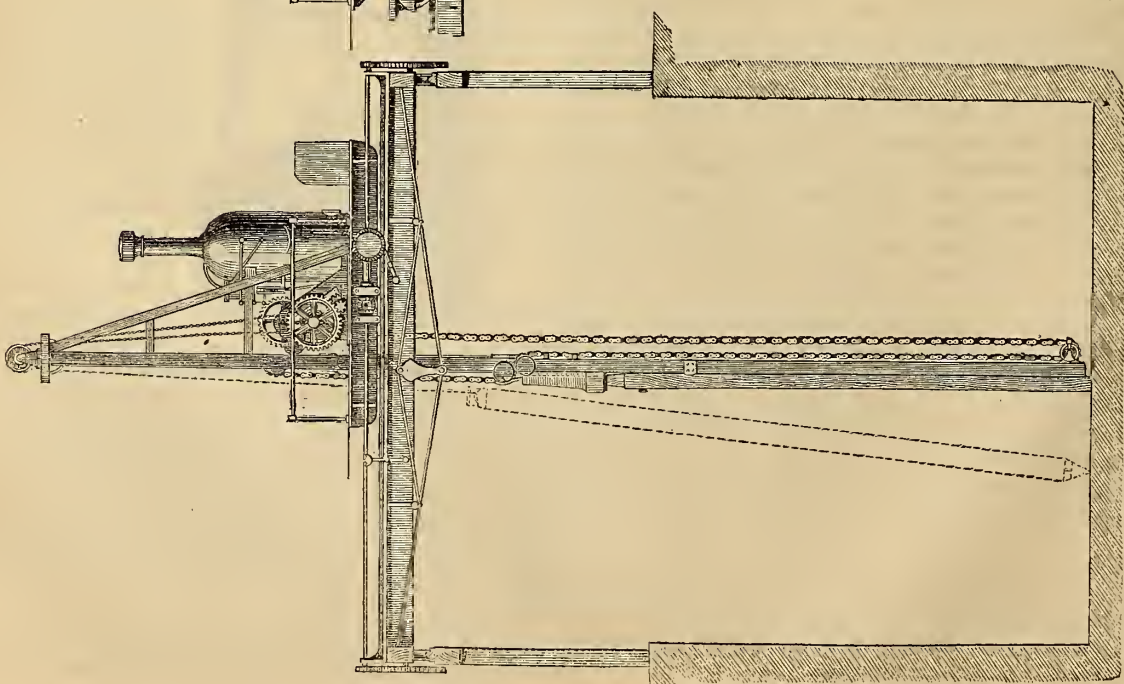


Fig. 2.

STEAMSHIP PERFORMANCE.

"SALAMIS" AND "HELICON."

We purpose to resume from time to time the accounts of the trials of the more important vessels in her Majesty's service, and, as far as we possibly can, deal analytically with the details. An account of the performances of the *Salamis* and *Helicon* is given in the following table, the data being obtained from the trials of the two vessels. The trial of the *Salamis* took place March 30th, 1865, and that of the *Helicon*, August 8th, 1865:—

	SALAMIS.		HELICON.	
	Full power.	Half power.	Full power.	Half power.
Nominal horse-power	250	....	250	....
Maker's name	Ravenhill	and Co.	Ravenhill	and Co.
Draught of water { Forward	10·4	....	9·11	....
Draught of water { Aft	10·5	....	10·3	....
Load on safety valve	25·0	....	25·0	....
Pressure of steam in boilers	25·0	22	25·0	25·0
Vacuum in condensers	24½	25	25·0	25½
No. of revolutions of engines { Maximum	32·5	27	....	....
No. of revolutions of engines { Mean	31·916	26·75	35	29½
Mean pressure in cylinders	27·254	14·937	28·858	18·668
Indicated horse power	1388·24	636·936	1610·06	877·8
Speed of vessel	13·689	11.433	14·500	12.478
Weather barometer	30·322	....	30·136	....
Wind { Force	1	....	2	....
Wind { Direction	N.W.	....	N.W. by W.	....
State of the sea	Smooth.	....	Smooth.	....
State of masts, yards, &c.	Complete.	....	Complete.	....
Quantity of coal on board	188 tons.	....	172 tons.	....
Quantity of stores	6 months.	....	6 months.	....
Paddle wheels. { Description	Feathering.	....	Feathering.	....
Paddle wheels. { Diameter	20′ 6″	....	20′ 6″	....
Paddle wheels. { Breadth of float	3′ 6″	....	3′ 3″	....
Paddle wheels. { Length of float	8′ 0″	....	8′ 0″	....
Paddle wheels. { Immersion of upper edge	1′ 10½″	....	1′ 6″	....

The principal dimensions of both vessels are as follows:—

Length between perpendiculars, 220ft.; extreme breadth, 28ft. 2in.; depth in hold to top of floor, 14ft. 6in.; burden in tons, 837. The hulls of the vessels differ in length, by about 6ft. in favour of the *Helicon*, owing to the prolongation of her bow. Their engines have each a pair of oscillating cylinders 61in. in diameter, with a stroke of 5ft. 6in. The *Salamis* may be regarded as representing the old, and the *Helicon* the new form of Admiralty clipper bow.

The *Helicon* was originally designed, and nearly completed in building, on similar lines to those of the *Salamis*, and possessing in common with it the then established Admiralty form of hollow lines forward, but by the advice of the Chief Constructor of the Navy, the fore body was taken down from the midship section, and reconstructed in the form it now exhibits, in a prolonged bow below the water line, with the floor of the vessel extended forward in the prolongation of the bow, the stem, from the water line, falling inboard, and fitted without the customary overhanging weight of figurehead, bowsprit, &c.

The accompanying woodcuts show the indicator diagrams taken from the engines of the two vessels. Figs. 1 and 2 are respectively taken from the starboard and port engines of the *Helicon*, Figs. 3 and 4 from those *Salamis*. The working of the engines of the two vessels as shown by the diagrams seems to be about the same in each case, after allowing for the difference in indicated horse-power.


FIG. 1.

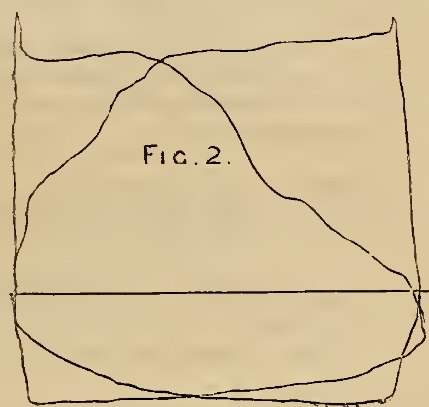


FIG. 2.

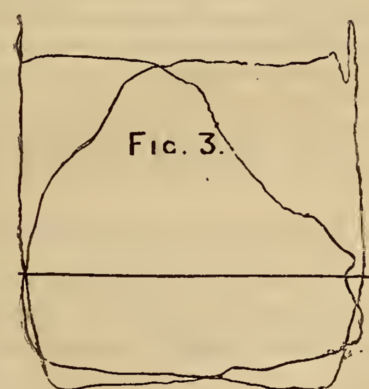


FIG. 3.

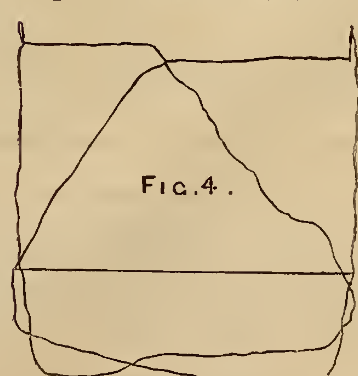


FIG. 4.

The indicated power as given in the table inserted above is for the *Helicon* 1610.06 H. P., and for the *Salamis* 1388.24 H. P., let us see what

difference of speed might have been expected had both vessels had the same lines. The power requisite to propel a vessel varies as the cube of the speed at which it is driven, hence the relative speeds of the *Salamis* and *Helicon* should be thus ascertained :—

$$\frac{\sqrt[3]{1610 \cdot 6}}{\sqrt[3]{1388 \cdot 24}} = \frac{\text{Speed of } \textit{Helicon.}}{\text{Speed of } \textit{Salamis.}} = \frac{11 \cdot 72}{11 \cdot 156} = 1 \cdot 0508$$

The speed of the *Salamis* was 13·689 knots, hence the speed of the *Helicon* due to its power should be

$$13 \cdot 689 \times 1 \cdot 051 = 14 \cdot 384 \text{ knots.}$$

But the actual speed attained was but 14·5 knots, which appears as showing the lines of the *Helicon* to be about equal at full speed to those of the *Salamis.*

It should, however, be observed here that when the *Helicon* was tried the force of the wind was 2, and when the *Salamis* was under experiment only 1. Let us now compare the speeds and powers of the two vessels when running at half boiler power :—

$$\frac{\sqrt[3]{877 \cdot 8}}{\sqrt[3]{636 \cdot 936}} = \frac{\frac{1}{2} \text{ speed of } \textit{Helicon.}}{\frac{1}{2} \text{ speed of } \textit{Salamis.}} = \frac{9 \cdot 575}{8 \cdot 603} = 1 \cdot 1149$$

The speed of the *Salamis* at half-power was 11·433, therefore that of the *Helicon* should have been—

$$11 \cdot 433 \times 1 \cdot 1149 = 12 \cdot 746 \text{ knots.}$$

whereas it was 12·478 knots.

We will now consider according to the above rule each vessel separately, to ascertain if it applies to the different speeds when the lines remain the same; first comparing the *Salamis*' speed at half power within that at full power we should have this relation :—

$$\frac{\sqrt[3]{1388 \cdot 24}}{\sqrt[3]{636 \cdot 936}} = \frac{\text{full speed of } \textit{Salamis.}}{\frac{1}{2} \text{ speed of } \textit{Salamis.}} = \frac{11 \cdot 156}{8 \cdot 603} = 1 \cdot 2966$$

The speed of the *Salamis* at half power being 11·433, that at full power should be

$$11 \cdot 433 \times 1 \cdot 2966 = 14 \cdot 823 \text{ knots.}$$

Her speed really was 13·689 knots, which it will be observed comes near the calculated quantity; dealing in the same manner with the *Helicon* we have

$$\frac{\sqrt[3]{1610 \cdot 6}}{\sqrt[3]{877 \cdot 8}} = \frac{\text{full speed of } \textit{Helicon.}}{\frac{1}{2} \text{ power speed of } \textit{Helicon.}} = \frac{11 \cdot 72}{9 \cdot 575} = 1 \cdot 2251$$

Hence the speed of the vessel at half power being 12·478, that at full power should be

$$12 \cdot 478 \times 1 \cdot 2251 = 15 \cdot 286 \text{ knots}$$

instead of which a speed of only 14·500 knots was attained.

Let us now see, taking the *Salamis* as a standard, how much power is lost or gained by the different form of the *Helicon* at full speed.

As the power requisite should vary as the cube of the speed attained, the proportional power of the *Helicon* would be

$$= 1388 \cdot 34 \times \frac{14 \cdot 5^3}{13 \cdot 689^3} = 1653 \cdot 1$$

but the indicated power was 1610·6, showing a slight saving of power due to the altered form of the *Helicon.*

(*To be continued.*)

PRICES OF MARINE ENGINES.

The following are the former prices of marine engines as tendered by the various manufacturers whose names are given. It will be observed that the number of manufacturers competing for the engines of larger power becomes reduced to four firms for engines of 800 horse power. Since the time when the list was made, engines of larger power have been made by each of the firms, and generally the facilities for producing much more powerful engines and gear have been generally extended in about the same proportion as that which appears upon the present list, although some of the houses formerly but little known have engines and tools quite as large as those produced by the four firms mentioned in the list now given.

The following is a list of the competing firms for supplying marine engines, boilers, and machinery whose offers are classified as follows :—

For engines up to 150 *nominal horse power, Admiralty rule.*

Martin, Samuelson, and Co., £41 12s.; Laird and Co., £46; Fawcett and Co., £46 13s. 4d.; Hawthorn and Co., £46 16s. 8d.; Greenock Foundry Co., £47 6s. 8d.; J. Key, £47 13s. 4d.; Day, Southampton, £48; Caird, Greenock, £48 13s. 4d.; Morrison, Newcastle, £49 18s. 4d.; Todd, MacGregor, and Co., £50; Thompsons', Glasgow, £50; Inglis, £50 13s. 4d.; Blyth, London, £51 6s.; Slaughter, Bristol, £52; Jackson and Watkins, London, £52; Randolph, Elder, and Co., Glasgow, £52 13s. 4d.; Humphreys, London, £54; G. and J. Rennie, £54; Maudslay, £55; J. Watts and Co., Soho, £58 18; Ravenhill and Co., £58; Napier and Sons, Glasgow, £58; Penn and Son, £60.

For Screw Engines up to 200 *nominal horse-power.*

Caird, £48 10s.; Thompson, £49 19s. 5d.; Inglis, £49; Randolph, Elder, and Co., £52; Humphreys, £53; Maudslay, £54; Napier, £54; Rennie, £54; Watt, £54 18s.; Penn, £57; Ravenhill. £56.

For engines up to 400 *nominal horse-power.*

Napier, £51; Humphreys, £52; Rennie, £52; Watt, £52 9s.; Maudslay, £53; Ravenhill, £53; Penn, £55.

For engines up to 500 *nominal horse-power.*

Napier, 51; Watt, £51 8s.; Rennie, £51 12s.; Maudslay, 52; Humphreys, £52; Ravenhill, £53; Penn, £56.

For engines up to 800 *nominal horse power.*

Maudslay, £51; Ravenhill, £52; Napier, £52; Penn, £55.

ON STEAM AS THE MOTIVE POWER IN EARTHQUAKES AND VOLCANOES.

By R. A. Peacock, Jersey.

(*Continued from* The Artizan *of November.*)

The table published in the June number, and referred to in the November number of The Artizan, so far as relates to M. Regnault's experiments was quoted from a table at p. 259,260 of the Rev R. V. Dixon's *Treatise on Heat.** His column of "force in inches of mercury" being reduced to lbs. per square inch, on the principle of taking 14·7lbs. to an atmosphere. The last line of the table is obtained from p. 183, where he says the pressure of about 28 atmospheres has a corresponding steam temperature of 230·56° Centigrade or 447° Fahr. The following are

Extracts from an unpublished M.S.

211. But it was right to go to the fountain head, and accordingly Vol. XXI. of *Memoires de l'Institut* has been referred to, where M. Regnault gives a full account of his steam experiments made for the French Government, and many tables of results. His experiments are as nearly perfect as anything merely human could be expected to be. In fact, more nearly so than could à priori have been expected, when we consider the many difficulties and dangers which he had to encounter and overcome. He gives the pressure in millemetres of mercury, taking 760 millemetres to an atmosphere. And he takes as his standard the Observatory of Paris in latitude 48° 50′ at 60 metres (196ft. 10in.) above the

* Hodges and Smith, Dublin, 1849.

level of the sea. Sir John Herschel gives* "mean barometric pressure at sea level on 1 square inch in lbs. 14·7304." But the pressure would be less than that at the Paris Observatory, nearly 200ft. above the sea.

Data used in calculating the three following Tables.

Specific gravity of mercury at 32° Fahr (water at 40°)	13·596
Hence a cubic foot of mercury weighs lbs.	849.75
And a column of mercury a metre high (39.37079 English inches) and one inch square, weighs lbs. ...	19.360678
And an atmosphere of 760 millemetres therefore weighs lbs.	14·714132
And it follows that an atmosphere will be equal to a column of mercury of the height, inches	29.9218

212. At p.p. 625-6 M. Regnault gives a table "des forces elastiques de la vapeur aqueuse" from which may be gathered by comparison with his table at p. 608, that the latter was calculated by his formula H. Table 2 now given is calculated from data obtained from his table at pp. 625-6, and it will be seen that his formula gives results all but identical with the $4\frac{1}{2}$ roots of the pressures, the differences being quite insignificant, for they range only from $\frac{1}{481}$ to $-\frac{1}{2703}$. There is therefore *practically no difference between his formula and that used by the present writer*:—

Table 2. Being extracts from M. Regnault's table calculated by his formula H., and given by him in Mem. de l'Institut, vol. 21, p. 625-6. Reduced by the present writer to English denominations, and compared with his own calculations, made as $4\frac{1}{2}$ roots of pressures.

M. Regnault's millemetres, reduced to lbs. pressure per sq. inch.	Mean temperatures centigrade, reduced to Fahrenheit.		Calculated as $4\frac{1}{2}$ roots of pressures. Temperatures.	Differences + or −	Differences per cent. + or −	
lbs. dec.	Cent. Deg.	Fahr. Deg.	Fahr. Deg.			
24·5767	115	239	239·3344	− ·3344	− ·140	
28·8722	120	248	248·0568	− ·0568	− ·023	
33·7627	125	257	256·8341	+ ·1659	+ ·065	
39·3076	130	266	265·661	+ ·339	+ ·127	
45·5699	135	275	274·5333	+ ·4667	+ ·170	
52·6152	140	284	283·4452	+ ·5548	+ ·195	
60·5128	145	293	292·3924	+ ·6076	+ ·207	
69·3351	150	302	301·3705	+ ·6295	+ ·208	$= +\frac{1}{481}$
79·1574	155	311	310·3752	+ ·6248	+ ·201	
90·0586	160	320	319·403	+ ·597	+ ·187	
102.1188	165	329	328·449	+ ·551	+ ·167	
115·422	170	338	337·51	+ ·49	+ ·145	
130·054	175	347	346·58	+ ·42	+ ·122	
146·1034	180	356	355·6605	+ ·3395	+ ·095	
163·6604	185	365	364·7433	+ ·2567	+ ·070	
182·8170	190	374	373·827	+ ·173	+ ·046	
203·6670	195	383	382·9072	+ ·0928	+ ·024	
226·3065	200	392	391·982	+ ·018	+ ·005	
250·8307	205	401	401·0473	− ·0173	− ·012	
277·3381	210	410	410·101	− ·101	− ·025	
305·925	215	419	419·13	− ·13	− ·031	
336·689	220	428	428·16	− ·16	− ·037	$= -\frac{1}{2703}$
369·732	225	437	437·161	− ·161	− ·037	
405·15	230	446	446·139	− ·139	− ·031	

Tables 3 and 4 give the highest temperatures used by M. Regnault in his experiments. Where two or more of his Nos. are mentioned in the same line, the mean results have been taken.

Note. It will be observed by comparison of columns 4 and 5 with each other, both in Table 3 and Table 4, that the temperatures are reduced a little too much by taking them as $4\frac{1}{2}$ roots of the pressure given in columns 2. And a small supplementary quantity viz. 0·543° F. *per cent.*, has been added in columns 6, which makes them nearly equal to the experimental temperatures given in column 4, the mean difference *per cent* averaging only 1 in 714 in Table 3; and being also insignificant in table 4, as will be seen by examination :—

Table 3. Being a selection of gradually increasing temperatures and pressures taken from Serie *y* of M. Regnault's experiments. See. Mem. de l'Inst. Vol. 21, p. 565-7.

M. Regnault's millemetres, reduced to lbs. pressure per sq. inch.	Mean mercurial temperatures centigrade, reduced to Fahrenheit.		Calculated as $4\frac{1}{2}$ roots of pressures. Temperatures.	$4\frac{1}{2}$ roots of pressures + 0·543 p. *per cent.* on col. 6	Differences between Col. 4 and Col. 6.	Differences *per cent.* between Col. 4 and Col. 6.	M. Regnaults' experiments.
lbs. dec.	Cent. Deg.	Fahr. Deg.	Fahr. Deg.	Fahr. Deg.			His Nos.
91·0665	161·17	322·106	320·194	321·943	+ ·163	+ ·050	3, 4, 5.
106·597	167·58	333·644	331·597	333·409	+ ·235	+ ·070	6, 7.
130·979	176·32	349·376	347·128	349·025	+ ·351	+ ·100	8, 9.
146·39	181·17	358·106	355·816	357·761	+ ·345	+ ·096	10, 11.
167·748	187·33	369·194	366·749	368·754	+ ·440	+ ·119	13.
193·392	193·82	380·876	378·528	380·596	+ ·280	+ ·073	19.
200·595	195·57	384·026	381·616	383·701	+ ·325	+ ·085	27, 28, 29.
240·71	204·48	400·064	397·394	399·566	+ ·498	+ ·124	30, 31, 32.
266·874	209·60	409·28	406·611	408·833	+ ·447	+ ·109	35.
287·818	213·685	416·633	413·495	415·757	+ ·876	+ ·210	36, 37.
314·336	218·24	424·832	421·674	423·981	+ ·851	+ ·200	42, 43.
321·834	219·46	427·028	423·89	426·209	+ ·819	+ ·192	45, 46.
316·738	218·675	425·615	422·387	424·698	+ ·917	+ ·215	48, 49.
						+ ·126	= mean difference or 1 in 714.
2	3	4	5	6	7	8	

Table 4 gives similar results.

213. It is clear, therefore, that the formula ought to stand as follows, (with the exception only that the two first and three last quantities in Table 4, column 8, are a little above the average, the intermediate twenty-four quantities giving only infinitesimal differences).

Corrected formula. Temperatures calculated as $4\frac{1}{2}$ roots of pressures + about 0·543° F. *per cent.* on column 6 = approximately the mean actual temperatures.*

214. M. Regnault says, p. 618, that the graphic curve by which he represents his pressures and temperatures in his large plate, "présente un point d'inflexion" at 627·2° C. (1160·96.° Fahr.) "Enfin" says he, "la courbe qui tournait sa *convexite* vers l'axe des températures" up to the temperature named, "tourne sa *concavite* vers ce même axe, à partir du point d'inflexion, l'ordonnée tend vers un maximum, et la courbe a pour asymptote, une "ligne parallèle à l'axe des températures, dont l'ordonnée est . . . 121,617 atmospheres" which amount to about 800 tons pressure per square inch. "Ce serait donc là la limite supérieure de la force élastique de la vapeur." As far as he can judge; but he very properly adds :—"Mais il serait à mon avis tout à fait deraisonnable d'attacher une signification reelle à ces points singuliers de la courbe, qui sont si loin en dehors des limites où nos observations peuvent atteindre." Supposing he is correct in saying that steam pressure may continue to increase up to about 800 tons per square inch and *no higher*, that force would still account for the greatest effects of earthquakes and volcanoes. Treating the temperature 3,000° by the empirical law in Sec. 213 for the moment, the quantity obtained is 925 tons; and by allowing for the increased differences per cent. in the last three Nos. of Col. 8, Table 4, the pressure would be reduced to about 900 tons. But the question of main importance is not, whether the highest steam pressure continues to increase as far as 800 tons, or 900 tons per square inch; but whether the pressure continues to

* Outlines of Astronomy, 1864, p. 716.

* The 0·543° F. per cent. has in reality been calculated on Colum 4, inadvertently; but the greatest difference, namely, for the last quantity, is only diminished thereby 0·193 per cent. (1 in 5,026), which is an insignificant difference.

increase *up to one of those or in some other enormously rapid ratio, or ratios, so as to account for the most powerful forces of earthquakes and volcanoes?* M. Regnault's views plainly tend towards an affirmative conclusion. And he is evidently an impartial witness, for he had no thought that his achievements and opinions had any bearing on the cause of earthquakes and volcanoes, because he never mentions either the one or the other; as it was no part of his object to enter into any considerations other than the phenomena connected with "Des Machines à Vapeur."

Table 4. Being a selection of gradually increasing temperatures and pressures, taken from Serie *z* of M. Regnault's experiments. See Mem. de l'Institut, Vol. 21, p. 568, &c.

M. Regnault's millemetres, reduced to lbs. pressure per square inch.	Mean mercurial temperatures Centigrade reduced to Fahrenheit.		As 4½ roots of Pressures.	4½ roots of pressures + 0·543° F. *per cent.* on experimental temperatures in col. 4.	Differences between Cols. 4 and 6.	Differences *per cent.* between Cols. 4 and 6.	M. Regnault's Experiments.
lbs. dec.	Cent.	Fahr.	Fahr.	Fahr.			His Nos.
25·6456	116·40	241·52	241·609	242·920	+1·400	— ·580	3
33.6925	125·15	257·27	256·7153	258·112	— ·842	— ·327	6
41·322	132·00	269·60	268·628	270·092	— ·492	— ·182	8
50·4629	138·91	282·038	280.827	282·358	— ·320	— ·113	10
61·9105	146·31	295·358	293·88	295·484	— ·126	— ·042	13
67·3625	149·45	301·01	299·444	301·078	— ·068	— ·022	16
71·7964	151·86	305·348	303·716	305·374	— ·026	— ·008	18, 19
79·4936	155·79	312·422	310·669	312·365	+ ·057	+ ·018	21
84·4232	158·14	316·652	314·85	316·569	+ ·083	+ ·026	24
89·8585	160·47	320·846	319·245	320·987	— ·141	— ·044	25, 26
94·7687	162·65	324·77	323·042	324·805	— ·035	— ·011	27, 28, 29
100·8593	165·24	329·432	327·544	322·333	+ ·099	+ ·030	33
111·493	169·365	336·857	334·922	336·751	+ ·106	+ ·031	34, 35
120·947	172·80	343·04	341·035	342·898	+ ·142	+ ·041	36
134·4498	177·39	351·302	349·179	351·087	+ ·215	+ ·061	38, 39
144·463	180·50	356·9	354·769	356·707	+ ·193	+ ·054	41, 42
156·638	184·13	363·434	361·206	363·179	+ ·255	+ ·070	46
166·972	187·05	368·69	366.372	368·374	+ ·316	+ ·086	48
183·701	191·44	376·592	374·228	376·273	+ ·319	+ ·085	49, 50
194·701	194·18	381·524	379·095	381·167	+ ·357	+ ·093	52
208·748	197·475	387·455	385·009	387·113	+ ·342	+ ·088	53, 54
234·836	203·16	397·688	395·218	397·377	+ ·311	+ ·078	57, 58
279·276	211·94	413·492	410·736	412·981	+ ·511	+ ·123	59, 60
305·05	216·51	421·718	418·873	421·163	+ ·555	+ ·131	62
326·338	220·15	428·27	425·2	427.525	+ ·745	+ ·174	65
352·997	224·31	435·758	432·685	435·051	+ ·707	+ ·162	67
382·9	228·89	444·	440·574	442·985	+1·015	+ ·229	76
409·034	232·56	450·608	447·086	449·533	+1·075	+ ·238	81
409·223	232·605	450·689	447·1317	449.5789	+1·1101	+ ·246	78,79,80,81
2	3	4	5	6	7	8	

215. If we were to hear a loud explosion and to see the fragments of a building flying in the air, and a cloud of smoke spreading itself among the ruins, and on entering the smoke to perceive the well known smell of gunpowder, we should naturally conclude that gunpowder was the cause of the catastrophe. So also in the late explosion at Erith, even if we had known that there was a portion of gun-cotton in each magazine, we should still call the accident a *gunpowder* explosion. Ought we not, then, to attribute the various species of natural disturbances of the earths crust chiefly or even entirely to steam, when it or its constituents are proved to have been present, as we shall now see in at least seventy cases, even if metallic bases of alkaloids were present also? Because amongst other reasons, we shall find in these evidences, Humboldt and Sir Humphrey Davy condemning the alkaloid theory as *co-operative* only. Whilst he would have a difficult task, who undertook to prove, that metallic bases of the alkaloids were always present in *sufficient quantity* to cause the greatest explosions. No such difficulty exists with regard to steam; indeed, it is self-evident that it may be present in all but unlimited quantity, the amount of oceanic and fresh water, and of subterranean fire being so inconceivably great. We shall see in evidence No. 40, that the Kaimeni submarine volcano has been active for 2,000 years. That is to say the Mediterranean has not been able to quench the fire, which must therefore be very vast. The like is true of the volcanoes under the Pacific Ocean, for its average depth is but as an exceedingly thin film when compared with the mass of the earth.

216. We know that "the terremotos of South America, indicate violent horizontal oscillations similar to the wave movements of the sea; or perpendicular upliftings, as if a power was operating on the roof of a cavern from the interior, struggling to force it open, and dash it away in fragments with everything upon it."* Very powerful steam might clearly do either of these things, according to whether the sides or the tops of the caverns offered the least resistance. We propose on a future occasion to prove that there must *necessarily* be caverns. The very powerful steam, if it increased in volume without increase of temperature, might lift a weight which it had not power to explode (just as every one can lift a weight which is too great for him to throw) and thus *slowly and gradually elevate a country,* Spitzbergen and northern Norway for example. On the other hand if steam ceased to be produced from any cause in a given cavity, the steam already contained therein would gradually cool by the natural conducting away of heat by the surrounding cooler ground, and allow the roof to settle; and so cause a *gradual continuous depression,* as in the south of Sweden.

217. In extensive reading on the subject of all kinds of natural disturbances of the earth's crust, the present writer has found no reason to believe, nor any allegation, that steam or its constituents are ever absent.

(*To be continued.*)

INSTITUTION OF CIVIL ENGINEERS.

At the meeting on the 5th ult., Mr. John Fowler, V.P., in the chair, the first ballot for the session 1865-66 was taken, when fifteen members and twenty-five associates were duly elected, including as members, Mr. James Danford Baldry, Westminster; Mr. William Cole Bayly, Bombay, Baroda, and Central India Railway; Mr. James Augustus Caley, assistant civil engineer in the western province of Ceylon; Mr. James Cross, St. Helen's; Mr. Frederick East, Madras Irrigation and Canal Company; Mr. Thomas Hardinge Going, Madras Railway; Mr. Hugh Leonard, superintending engineer in the Department of Public Works of Bengal; Mr. Edward Orpen Moriarty, engineer-in-chief for harbours and rivers, Sydney, N.S.W.; Mr. Parke Neville, engineer to the corporation of Dublin; Mr. William Henry Price, superintending engineer of the Kurrachee harbour works; Mr. Cubitt Sparkhall Rundle, Calcutta; Mr. Bernhard Schmidt, resident engineer of the Berlin-Gorlitzer Railway; Mr. Charles Tarrant, county surveyor of Waterford; Mr. Cromwell Fleetwood Varley, chief engineer to the Electric and International Telegraph Company; and Mr. Edward Wilson, Worcester; and as Associates, Mr. Joseph Brierley, Blackburn; Mr. Thomas Buckham, Wandsworth; Mr. Seymour Clarke, general manager of the Great Northern Railway; Mr. William Clarke, late of New Zealand; Mr. John Dickson Derry, assistant engineer in the Department of Public Works of Bengal; Mr. John Dunning, Middlesbro'-on-Tees; Mr. Cornelius Willes Eborall, general manager of the South Eastern Railway; Mr. James Grierson, general manager of the Great Western Railway; Mr. Richard Harris Hill, London; Mr. George William Horn, of the London and South Western Railway; Major Julian St. John Hovenden, R.E., deputy consulting engineer to the Government of India in the railway department; Mr. Francis King, Bombay; Mr. Conyers Kirby, Newport (Mon.); Mr. William Lang, London; Colonel William Montagu Scott M'Murdo, C.B.; Mr. Robert Messer, late of Oporto; Mr. Robert Moseley, manager of the Great Eastern Railway; Mr. William Newmarch, F.R.S., London; Mr. Jeremiah Ryan, Bombay; Mr. Archibald Scott, traffic manager of the London and South Western Railway; Mr. Edward Rush Turner, Ipswich; Mr. Howard Unwin, Carmarthen; Mr. Leveson Francis Vernon-Harcourt, M.A., Westminster; Mr. George Ambrose Wallis, Eastbourne; and Mr. George Woolcott, F.R.G.S., secretary to the Central Argentine Railway Company.

At the meeting held on the 12th ult., John Robinson M'Clean, Esq., President, in the Chair, the paper read was on "Experiments on the Strength of Cement,

* Milner's Gallery of Nature, p. 430

chiefly in reference to the Portland Cement used in the Southern Main Drainage Works," by Mr. John Graut, M. Inst. C.E.

This communication related to an extensive series of experiments, the results of which were recorded in voluminous tables, forming an appendix to the paper, carried on during the last seven years, with a view to ensure, as far as possible, that only cement and other materials of the best quality should be employed in the Southern Main Drainage Works, of which the author had charge as resident engineer.

As a preliminary step, samples of Portland cement were obtained from all the principal manufacturers for the purpose of experiment. The average weight of these samples was found to be 108·6lbs. per bushel, and they sustained breaking or tensile strains, at the end of a month, varying from 75lbs. to 719lbs. upon $2\frac{1}{4}$ square inches. A clause was then inserted in the specifications to the effect that the Portland cement to be used in the works should be of the very best quality and ground extremely fine, weighing not less than 110lbs to the striked bushel, and capable of resisting a breaking weight of 400lbs. upon an area $1\frac{1}{2}$in. square, equal to $2\frac{1}{4}$ square inches, seven days after being made, and after being immersed in water for the whole of that time. The standard was subsequently raised to 500lbs. on the same sectional area, which was that used throughout the experiments. During the last six years 70,000 tons of Portland cement had been used in these works, which extended over a length of 18 miles, and had cost £1,250,000. This quantity of cement had been submitted to about fifteen thousand tests, at a cost of only five farthings per ton. The machine devised for showing the tensile strain was a lever balance, constructed by Mr. P. Adie (Assoc. Inst. C.E.), and its first cost was from £40 to £50. It was so simple that an ordinary workman could be trusted to test the cement, and the cost for labour did not exceed £80 per annum for each machine.

The manufacture of Portland cement required extreme care in the admixture of its two simple and well-known ingredients, clay and chalk, it being necessary to vary the proportions according to the quality of the chalk; thus, in white chalk districts, the clay formed from 25 to 30 per cent., and in grey chalk districts from 16 to 20 per cent. of the whole bulk. The manufacture was carried on almost exclusively on the banks of the Rivers Thames and Medway; the clay, which should be as free from sand as possible, being obtained from the creeks and bays between Sheerness and Chatham. Long experience now enabled the Clerks of the Works and others to detect the qualities of the cements by colour and by weight. Very strong Portland cement was heavy, of a blue grey colour, and set slowly; in fact, the longer it was in setting, the greater was its strength. Quick-setting cement had generally too large a proportion of clay in its composition, was brown in colour, and turned out weak, if not useless. In the first schedule of prices, 2*s.* 3*d.* per bushel was inserted, but this was far above its present market value.

But the tests were not alone sufficient. It was essential that constant supervision should be exercised to ensure that only clean and sharp sand should be mixed with the cement, that the cement was only supplied with sufficient water to reduce it to a state of paste, which was best accomplished by means of a perforated nozzle at the end of a pipe or watering can; that the bricks or stones were thoroughly saturated with water so that in setting, the cement might not be robbed by absorption of the moisture necessary for its perfect hardening; and that a current of water was prevented from passing over the cement, or through the joints, during the process of setting, as this would wash away the soluble silicates.

The results, as a rule, were the average of ten tests, the samples being immersed under water from the time of setting to the time of testing. The tables showed that, during the last six years, 1,369,210 bushels of Portland cement had been submitted to 11,587 tests, and that the cement was found to be of the average weight of 114·5 lbs. per bushel, and to possess an average tensile strength of 608·6 lbs. upon $2\frac{1}{4}$ square inches, being $51\frac{1}{2}$ and 21 per cent. in excess of the two specified standards. It was also ascertained that, provided Portland cement be kept free from moisture, it did not, like Roman cement, lose its strength by being kept in casks or in sacks, but rather improved by age—a great advantage in the case of cement which had to be exported. Experiments, conducted over periods varying from one week to twelve months, with Portland cement weighing 112 lbs. to the imperial bushel, guaged neat and mixed with varying proportions of different kinds of sand, showed that neat cement was stronger than any admixture of it with sand; that mixed with an equal quantity of sand (as has been the case throughout the Southern Main Drainage Works), the cement might be said to be, at the end of a year, approximately three-fourths of the strength of neat cement; that with two, three, four, and five parts of sand to one of cement the strength was respectively one-half, one-third, one-fourth, and about one-sixth that of neat cement. Other experiments showed that at the end of twelve months, neat cement kept under water in a quiescent state was about one-third stronger than that which was out of water, both indoors and exposed out of doors to the action of the weather; that blocks of brickwork, or concrete, made with Portland cement, if kept under water until required for use, would be much stronger than if allowed to remain dry; and that salt-water was as good for mixing with Portland cement as fresh water. Bricks of neat Portland cement, after being made three, six, and nine months, withstood a crushing force of 65, 92, and 102 tons respectively, or equal to the best quality of Staffordshire blue bricks; and bricks of cement mixed with four and five parts of sand, bore a pressure equal to the best picked stock bricks; while Portland stone of a similar size, bore on its bed a crushing weight of 47 tons, and against its bed somewhat less, and Bramley fall stone sustained on its bed $93\frac{1}{3}$ tons, and against its bed $54\frac{2}{3}$ tons. Portland cement concrete made in the proportions of one of cement to six or eight of ballast, had been extensively used for the foundations of the river wall and the piers of the reservoirs at Crossness, as well as for the foundations generally both there and at Deptford, with the most perfect success. It was thought that it might be still more advantageously used as a substitute for brickwork or masonry, wherever skilled labour, stone or bricks were scarce, and foundations had to be made with the least expenditure of time and money. Whenever concrete was used under water, care must be taken that the water was still, as a current, whether natural or caused by pumping, would carry away the cement and leave only clean ballast. Roman cement, though about two-thirds of the cost of Portland, was only about one-third its strength, and was therefore double the cost when measured by strength. It was, besides, very ill adapted for being mixed with sand.

In conclusion, the author, whilst recommending Portland cement as the best article of the kind that could be used by the engineer or architect, warned every one who was not prepared to take the trouble, or incur the trifling expense of testing, not to use it; as, if manufactured with improper proportions of its constituents, chalk and clay, or improperly burnt, it might do more mischief than the poorest lime. Further experiments were desirable, on the strength of adhesion between bricks and cement, under varying circumstances; on the limit to the increase of strength with age; on the relative strength of concrete made with various proportions of cement and ballast; and on the use of cement in very hot climates, where probably extra care would be required in preserving the cement from damp, and keeping it cool until the process of setting had been completed. On these and other important points, the author trusted that all who had the opportunity would record their observations, and present them to the Institution.

Annual General Meeting.

At the annual general meeting on December 19th, 1865, John Robinson M'Clean, Esq., president, in the chair, it was remarked, in the report of the council, that the position which the institution had now attained must be satisfactory to all its members, and eminently so to those few still living, who, many years ago, when young men, laboured earnestly to secure for it a recognised place among the scientific societies of the Metropolis. They seemed to have anticipated that a time would arrive when, as a matter of course, every one in any way connected with the profession would belong to the institution; for in the Charter of Incorporation granted in the year 1828, as well as in the by-laws and regulations based upon that charter, the designation "Civil Engineer" was made to embrace every branch of engineering except that devoted to the military art. It was well that this should be constantly borne in mind, so as to prevent that which should ever be one united body being split up into sections. There seemed to be no reason why, at this time, any limitations should be introduced, or any restrictions be imposed, tacitly or otherwise, which might operate to render less comprehensive and complete the perfect embodiment of the profession in the institution; and in that view efforts should be directed to consolidate all branches under one corporation, and thus to add materially to the power, influence, and importance of the profession at large.

There had been twenty-four ordinary general meetings during the past session, when twelve "papers" only, out of those submitted to the Council, had been read, owing to the protracted and animated discussions to which they gave rise. Of these communications one-half had reference distinctly to foreign enterprises or discoveries, including—a description of Giffard's Injector, probably one of the most ingenious and scientific pieces of mechanism of modern times; an account of the docks and warehouses of Marseilles, where the imports and exports were estimated to amount to three million tons per annum; a notice of the Chey-Air bridge on the Madras Railway, and particularly as to the methods employed for raising the water out of the foundations; an account of the drainage of Paris; and two essays on the decay of materials in tropical climates, and the methods employed for arresting and preventing it. At home the works for the main drainage of London and for the interception of the sewage from the River Thames, were fully detailed and illustrated; a description was given of the Great Grimsby (Royal) Docks, with a minute account of the enclosed land, entrance locks, dock walls, &c.; the particulars were recorded of a highly interesting experiment—the employment of locomotive engines, for passenger traffic, on the Festiniog Railway, a mineral line with a gauge of two feet only; the maintenance of railway rolling stock was the subject of a useful communication, embodying the statistics, for a period of thirteen years, of all the stock belonging to the North-Eastern Railway Company; a careful and elaborate inquiry on the uniform stress in girder work, suggested by a previous discussion at the institution, and by which it was sought to be maintained that uniform stress was perfectly consistent with the utmost economy of materials; and a description of the River Tees, and of the works upon it connected with the navigation.

It was stated that arrangements had been made by which vol. xxii. of the Minutes of Proceedings would be in the hands of the members in February next, vols. xxiii. and xxiv. in the months of May and August following, and vol. xxv. for the present session before the meetings were again resumed in November, 1866.

In the belief that many members and associates of the institution were in the habit of making observations and experiments on subjects connected with engineering science, which were seldom published, but remained as notes in memorandum books, and in time were lost, the council urged the members to contribute results of this kind, for the purpose of forming an Appendix to the Minutes.

About three hundred volumes had been added to the library during the year; and a portrait of the late Sir William Cubitt, Past President, by Mr. Boxall, R.A., had been received from his son, Mr. Cubitt.

The tabular statement of the transfers, elections, deceases, and resignations, showed that the number of elections had been 142, of deceases 21, of resignations 5, and of erasures 8, leaving an effective increase of 108, and making the total number of members of all classes on the books on the 30th of November last, 1,203. This was an increase of nearly nine per cent. on the present number in the past twelve months.

The deceases announced during the year had been:—Sir William Lubbock, Bart., honorary member; Colonel Frederick Blom, Frederick Braithwaite, John Isaac Hawkins, Captain Gustaf Lagerheim, John Lewis, James Beaumont

Neilson, Jacob Perkins, Frederick Walter Simms, and General Alexander Wilson, members; George Abernethy, John George Appold, Mathias Wolverley Attwood, William Henry Richards Curll, William Johnson, Edwin Marshall, Benjamin Oliveira, Sir Joseph Paxton, John Francis Porter, Andrew John Robertson, and Douglas Sutherland, Associates. By the will of the late Mr. Appold, whose interest in the welfare of the society was unflagging, provision was made for a sum of £1,000 being conveyed to the Institution on the decease of Mrs. Appold.

An examination of the statement of receipts and expenditure showed that, during the year ending the 30th of November last, the receipts from subscriptions and fees alone amounted to £3,950, as against disbursements of all kinds of £3,511; while the income account was further increased by the dividends upon trust funds amounting to £353, and upon other investments (not being in trust) of £400, as well as by miscellaneous receipts to the extent of £350. Twelve years ago, in the annual report for the session 1853-54, the total income of the institution was estimated to amount to £1,923, and the expenses, exclusive of the minutes, to £1,649. In the interval the receipts had been increased from subscriptions and fees more than twofold, and from dividends and other sources more than seven times; on the other hand, the disbursements, exclusive also of the minutes, had in the last year been £2,086 only, against the estimated sum of £1,649 at the former period. The realised property of the institution now comprised:—I. General funds, £12,510 3s. 6d.; II. Building fund, £2,502 5s. 5d.; and III. Trust funds, £9,970 12s. 7d., making a total of £24,983 1s. 6d. as against £22,541 5s. 6d. at the date of the last report.

The benevolent fund established, in connection with the institution, twelve months ago had since been fully organised, and a committee of management appointed, who would in due course have to report to the subscribers to the fund. It might, however, be stated, that the donations actually received had amounted to £22,782 17s., and the annual subscriptions for 1865 to £712 16s., being in the former case a little in excess of the sum promised, and in the other an increase of thirty per cent.

A private bill to be submitted to Parliament in the ensuing session, and for which plans had been deposited and the usual notices served, appeared calculated to affect very seriously the interests of the institution. The council felt it to be their duty to direct attention to this subject, believing it to be one which demanded serious consideration.

After the reading of the report, Telford medals and Telford premiums of books were presented to Messrs. J. W. Bazalgette, C. Reilly, E. H. Clark, and Capt. H. W. Tyler, R.E.; Telford premiums of books to Messrs. T. Hawthorn, E. Fletcher, E. Johnston, G. O. Mann, W. J. W. Heath, and J. Taylor; and the Manby premium in books to Mr. H. B. Hederstedt.

The thanks of the institution were unanimously voted to the president for his attention to the duties of his office; to the vice-presidents and the other members and associates of council for their co-operation with the president, and their constant attendance at the meetings; to Mr. Charles Manby, honorary secretary, and to Mr. James Forrest, for the manner in which they had performed the duties of their offices; as also to the auditors of the accounts, and the scrutineers of the ballot, for their services.

The following gentlemen were elected to fill the several offices on the council for the ensuing year:—John Fowler, president; Joseph Cubitt, Charles Hutton Gregory, Thomas Hawksley, and John Scott Russell, vice-presidents; James Abernethy, William Henry Barlow, John Frederic Bateman, Nathaniel Beardmore, James Brunlees, Thomas Elliot Harrison, George Willoughby Hemans, John Murray, George Robert Stephenson, and Charles Vignoles, members; and Joseph Freeman and John Kelk, M.P., Associates.

ROYAL INSTITUTION OF GREAT BRITAIN.

SYNTHETICAL RESEARCHES UPON ETHERS.—SYNTHESIS OF ETHERS FROM ACETIC ETHERS.

By E. FRANKLAND, F.R.S., Professor of Chemistry in the Royal Institution of Great Britain, and in the Royal School of Mines, and B. F. DUPPA, Esq.

(Abstract.)

In a recent note* we have briefly described the synthesis of butyric and diethacetic ethers by acting consecutively upon acetic ether with sodium and the iodide of ethyl. In the present paper we have the honour to lay before the Royal Society the detailed results of one section of this research, embracing the action of sodium and the iodides of methyl, ethyl, and amyl upon acetic ether.

I. *Action of Sodium and Ethyl Iodide upon Acetic Ether.*

When acetic ether is treated with sodium at a temperature gradually rising to 120° C., hydrogen is evolved, and a thick brownish liquid produced; the latter solidifies on cooling to a yellowish mass, presenting the appearance of beeswax. On digesting this solid mass with ethylic iodide at 100° C. for several hours, a number of products are formed, which, on the addition of water, may be distilled off from a residue consisting chiefly of iodide of sodium. The distillate can readily be separated into an aqueous and an oily portion. The latter then presented the appearance of a light straw-coloured oil, possessing a pleasant and fragrant odour. It was washed and then dried over chloride of calcium, and submitted to fractional distillation, by which traces of alcohol, acetic ether, and ethyl iodide were effectually removed from the other products, which now boiled between 120° and 265° C. We have described the constituents of this complex liquid under two distinct heads, viz.:—

1st. Products depending upon the duplication of the atom of acetic ether.

2nd. Products derived from the replacement of hydrogen in the methyl of acetic ether by the alcohol-radicals.

In order successfully to separate the two products from each other, and especially to disentangle their constituent compounds, it is absolutely necessary to operate upon large quantities of material. But if this be done, there is obtained a considerable quantity of the products of the first division boiling between 204° and 208°, whilst the products of the second division boil considerably below these temperatures.

a. Examination of the products depending upon the duplication of the atom of acetic ether.

Submitted to analysis, this liquid was found to consist of two bodies of the formulæ

$$C_{10}\,H_{18}\,O_3, \text{ and } C_8\,H_1\,O_{43},$$

separable from each other by repeated rectification, and also by the action of boiling aqueous potash, which decomposes the second but scarcely affects the first.

From the results of the analysis, and from considerations which are fully entered into in the paper, we propose for these bodies the following names and formulæ:—

$$\text{Ethylic diethacetone carbonate ………} C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{(C_2\,H_5)_2} \\ \overline{O''} \\ O\,C_2\,H_5 \end{array}\right.$$

$$\text{Ethylic ethacetone carbonate…………} C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{C_2\,H_5} \\ H \\ \overline{O''} \\ O\,C_2\,H_2 \end{array}\right.$$

The production of ethylic diethacetone carbonate is explained in the following equations:—

$$\underset{\text{Acetic ether.}}{2C_2\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ O\,C_2\,H_5 \end{array}\right.} + Na_2 = C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{Na_2} \\ \overline{O''} \\ O\,C_2\,H_5 \end{array}\right. + \underset{\text{Alcohol.}}{\left.\begin{array}{c} C_2\,H_5 \\ H \end{array}\right\}O} + H_2$$

$$C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{Na_2} \\ \overline{O} \\ O\,C_2\,H_5 \end{array}\right. + 2\,C_2\,H_5\,I = \underset{\text{Ethylic diethacetone carbonate.}}{C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{(C_2\,H_5)_2} \\ \overline{O''} \\ O\,C_2\,H_5 \end{array}\right.} + 2\,Na\,I$$

Ethylic diethacetone carbonate is a colourless and somewhat oily liquid, possessing a fragrant odour and a pungent taste. It is insoluble in water, but miscible in all proportions with alcohol and ether. Its specific gravity is ·9738 at 20° C. It boils between 210° and 212°, and distils unchanged. The density of its vapour was found to be 6·59. The above formula, corresponding to two volumes, requires the number of 6·43. Boiling aqueous solutions of potash and soda have scarcely any action on ethylic diethacetone carbonate, but baryta-water and lime-water decompose it with great facility, as do also boiling alcoholic solutions of potash and soda. In all cases a carbonate of the base is precipitated, and alcohol, together with a light ethereal liquid, is separated.

This liquid, freed from alcohol by repeated washing with salt and water, boiled, after drying over chloride of calcium, between 137·5° and 139° C. Submitted to analysis, it yielded results corresponding with the formula

$$C_7\,H_{14}\,O.$$

We regard this body as *diethylated acetone.* Its formula and its relations to acetone may be thus expressed:—

$$\underset{\text{Acetone.}}{\left\{\begin{array}{l} C\,H_3 \\ C\,Me\,O \end{array}\right.} \qquad \underset{\text{Diethylated acetone.}}{\left\{\begin{array}{l} C\,Et_2\,H \\ C\,Me\,O \end{array}\right.}$$

Diethylated acetone is produced from ethylic diethacetone carbonate by the action of alcoholic potash according to the following equation:—

$$\underset{\text{Ethylic diethacetone carbonate.}}{C_4\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{(C_2\,H_5)_2} \\ \overline{O''} \\ O\,C_2\,H_5 \end{array}\right.} + 2\,K\,H\,O = \underset{\text{Potassium carbonate.}}{C\left\{\begin{array}{l} O \\ O\;K \\ O\;K \end{array}\right.} + \underset{\text{Alcohol.}}{C_2\,H_5\,O\,H} \; \underset{\text{Diethylated acetone.}}{C_3\left\{\begin{array}{l} H_3 \\ \overline{O''} \\ \overline{(C_2\,H_5)_2} \\ \quad H \end{array}\right.}$$

Diethylated acetone is a colourless, transparent, and mobile liquid, possessing a penetrating odour of camphor, and the burning and bitter after-taste of the same substance. It is very slightly soluble in water, but miscible in all proportions with alcohol and ether. Its specific gravity is ·8171 at 22° C. It boils at 137·5° to 139° C. A determination of its vapour density gave the number 3·86, the above formula requiring 3·93. Diethylated acetone does not oxidise in the air, neither does it reduce ammoniacal solution of nitrate of silver when boiled with it. Mixed with concentrated solution of sodium bisulphite, it forms an oily compound which scarcely exhibits signs of crystallisation at 0° C. It

* Proceedings of the Royal Society, vol. xiv. p. 198.

suffers no alteration by prolonged boiling with alcoholic potash. It is isomeric with butyrone, with a ketone obtained by Fittig* in the distillation of calcium valerianate, and with œnanthol. From the first it is distinguished by its lower boiling point (138°), butyrone boiling at 144° C., and Fittig's ketone at 161° to 164°, and from the third by its different properties, which are essentially those of a ketone and not of an aldehyde. The difference in structure of three of these bodies may be expressed with considerable certainty by the following formulæ:—

$$\left\{\begin{array}{l} C\,Et_2\,H \\ C\,Me\,O \end{array}\right. \qquad \left\{\begin{array}{l} C\,Et\,H_2 \\ C\,(Pr)\,O \end{array}\right. \qquad \left\{\begin{array}{l} C\,(Aq)\,H_2 \\ C\,H\,O \end{array}\right.$$

Diethylated acetone. Butyrone. Œnanthol.

Ethylic ethacethne carbonate is produced by the action of sodium and ethylic iodide upon acetic ether, according to the following equations:—

$$C_2\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right. + Na = C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline Na \\ H \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right. + \underset{\text{Alcohol.}}{C_2\,H_5\,O\,H} + H$$

Acetic ether. Ethylic sodacetone. carbonate.

$$C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline Na \\ H \\ \hline O' \\ \hline O\,C^2\,H_5 \end{array}\right. + C_2\,H_5\,I = C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline C_2\,H_5 \\ H \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right. + Na\,I.$$

Ethylic sodacetone carbonate. Ethylic ethacetone carbonate.

Ethylic ethacetone carbonate is a colourless and transparent liquid, possessing a very fragrant odour and an aromatic taste. It is nearly insoluble in water, but miscible in all proportions with alcohol and ether. Its density in the liquid condition is ·9834 at 16° C. It boils at 195° C., and distils without decomposition. A determination of its vapour-density gave the number 5·36. The above formula reqnires 5·45. Ethylic ethacetone carbonate is readily attacked by boiling aqueous solutions of potash and soda, yielding carbonates of these bases, alcohol, and *ethylated acetone*, according to the following equation:—

$$C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline C_2\,H_5 \\ H \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right. + 2\,K\,H\,O = C\left\{\begin{array}{l} O'' \\ O\,K \\ O\,K \end{array}\right. + \underset{\text{Alcohol.}}{C_2\,H_5\,O\,H} + C_3\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline C_2\,H_5 \\ H_2 \end{array}\right.$$

Ethylic ethacetone carbonate. Ethylated acetone.

Ethylic ethacetone carbonate is still more readily decomposed by aqueous solution of baryta and by alcoholic potash, in both cases ethylated acetone and a carbonate of the base is produced.

Ethylated acetone may be freed from alcohol by repeated washing with salt and water, but it is best obtained in a state of absolute purity by combination with, and separation from, bisulphate of soda. Ethylated acetone thus purified and rectified from quicklime yielded on analysis numbers agreeing well with the formula

$$C_5\,H_{10}\,O,$$

which may be reduced to the radical type as follows:—

$$C_3\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline C_2\,H_5 \\ H_2 \end{array}\right. \qquad \left\{\begin{array}{l} C\,H_3 \\ O'' \\ \hline C_2\,H_5 \\ H_2 \end{array}\right. = \left\{\begin{array}{l} C\,Et\,H_2 \\ C\,Me\,O \end{array}\right.$$

Its relations to acetone and diethylated acctonc are then clearly seen in the following formula,

$$\left\{\begin{array}{l} C\,H_3 \\ C\,Me\,O \end{array}\right. \qquad \left\{\begin{array}{l} C\,Et\,H_2 \\ C\,Me\,O \end{array}\right. \qquad \left\{\begin{array}{l} C\,Et_2\,H \\ C\,Me\,O \end{array}\right.$$

Acetone. Ethylated acetone. Diethylated acetone.

Ethylated acetone is a colourless, transparent, and very mobile liquid, possessing a powerful and pleasant odour, in which that of camphor is slightly perceptible. Its specific gravity is ·8132 at 13° C., and ·8046 at 22° C. It boils steadily at 101·5°, and its vapour has the density 2·951, the above formula requiring 2·971. Ethylated acetone neither absorbs oxygen from the air, nor reduces ammoniacal solutions of sulphur. It yields with concentrated solutions of bisulphate of soda a compound in large and brilliant crystals, which are quite permanent in the air, and which at once distinguish it from diethylated acetone, the latter producing under the same circumstances an oily compound. Ethylated acetone is not altered by prolonged ebullition with alcoholic potash.

β. Examination of the products derived from the replacement of hydrogen in the methyl of acetic ether by ethyl.

The chief results of this examination are given in the note previously alluded to,* and we have only to add that ethacetic acid is identical with butyric acid, whilst diethacctic acid is isomeric with caproic acid.

II. *Action of Sodium and Methylic Iodide upon Acetic Ether.*

This reaction is conducted in substantially the same manner as that above described, and the products are completely homologous. Thus there are produced two carboketonic ethers, and an ether derived from acetic ether by the substitution of methyl for hydrogen. The latter has been already described in our previous communication on this subject.

The following are the names and formulæ of the carboketonic ethers:—

$$\text{Ethylic dimethacetone carbonate}\;\ldots\ldots C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline (C\,H_3)_2 \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right.$$

$$\text{Ethylic methacetone carbonate}\;\ldots\ldots\ldots C_4\left\{\begin{array}{l} H_3 \\ \hline O'' \\ \hline C\,H_3 \\ H \\ \hline O'' \\ \hline O\,C_2\,H_5 \end{array}\right.$$

The reactions involved in the production of these bodies are exactly similar to those by which the corresponding ethylic bodies are formed.

Ethylic dimethacetone carbonate is a colourless, slightly oleaginous liquid, possessing a peculiar penetrating and pleasant odour, and a sharp burning taste. It is scarcely at all soluble in water, but readily so in alcohol and ether. Its specific gravity is ·9913 at 16° C., and distils unchanged. A determination of its vapour-density gave the number 5·36, the above formula requiring 5·45. Its remaining proprieties very closely resemble those of ethylic diethacetone carbonate. Boiled with baryta-water, it gives barium carbonate and *dimethylated acetone,*

$$\left\{\begin{array}{l} C\,Me\,H_2 \\ C\,Me\,O \end{array}\right.$$

Dimethylated acetone is a colourless, transparent and very mobile liquid, possessing a pleasant odour, reminding at the same time of parsley and acetone. Its specific gravity is ·8099 at 13° C., and it boils at 93·5° C. Its vapour-density is 2·92, theory requiring 2·97. Dimethylated acetone closely resembles its ethylic homologue in all its chemical properties; like diethlated acetone, it is oxidized with difficulty, and does not very readily form a crystalline compouud with bisulphite of soda—differing in the latter respect markedly from its isomer, ethylated acetone, and also from methylated acetone described below.

Ethylic dimethacetone carbonate and ethylic methacetone carbonate boil at the same temperature, and cannot therefore be separated by rectification; but we have prepared and examined the ketone from the second of these bodies; viz., *methylated acetone,* which has the formula

$$\left\{\begin{array}{l} C\,Me\,H_2 \\ C\,Me\,O \end{array}\right.$$

Methylated acetone is best obtained in a state of purity by combining it with bisulphate of soda, pressing the beautiful crystalline compound so formed between folds of blotting-paper to remove traces of dimethylated acetone, exposing it over sulphuric acid *in vacuo*, and then regenerating the methylated acetone by distillation with aqueous potash. The liquid so obtained, after drying over quicklime and rectification, gave analytical results corresponding with the above formula.

Methylated acetone is a colourless, transparent and very mobile liquid, possessing an odour like chloroform, but more pungent. It is tolerably soluble in water, and more than slightly so in a saturated solution of common salt. Its specific gravity is ·8125 at 13° C. It boils at 81° C., and its vapour-density is 2·52, the above formula requiring 2·49. Methylated acetone is identical with the ethyl-acetyl obtained by Freund in acting upon chloride of acetyl with zinc ethyl. Methylated acetone forms a splendidly crystalline compound with bisulphite of soda, and in its other chemical properties so closely resembles ethylated acetone as to require no further description. It retains alcohol with such tenacity as to render its separation from that liquid by washing and treatment with chloride of calcium almost impossible. This separation, however, is readily effected by bisulphite of soda.

3. *Action of Sodium and Amyl Iodide upon Acetic Ether.*

For this reaction the compounds of sodium derived from acetic ether were prepared as before, and were then submitted to the action of amylic iodide for several hours at the boiling-point of the mixture. When the sodium had all become converted into iodide, water was added and the supernatant liquid decanted. We reserve a complete description of this liquid for our next communication, and will here confine ourselves to the separation from it of œnanthylic acid, which was obtained as follows:—The crude product, after drying over chloride of calcium, was submitted to rectification, and the portion boiling between 170° and 190° C. collected apart and decomposed by ebullition with alcoholic potash. By this treatment we destroyed any ethylic amylacetone carbonate and ethylic diamylacetone carbonate that were present, and obtained a potash-salt of an acid derived from acetic acid by the substitution of one atom of amyl for one of hydrogen. The potash-salt thus obtained was distilled with excess of sulphuric acid diluted with a large quantity of water. Upon the distillate there floated an oily acid, possessing an odour resembling œnanthylic acid. This acid was converted into an ammonia-salt, from which a silver-salt

* Ann. Ch. Pharm., vol. cxvii. p. 68.

* Proceedings of Royal Society, vol. xiv. p. 198.

was prepared by precipitation. After being well washed with cold water, this salt yielded numbers on analysis closely corresponding with the formula of amylacetate or œnanthylate of silver:

$$C_2\left\{\begin{array}{l} C_5\,H_{11} \\ H_2 \\ \hline O'' \\ O\,Ag \end{array}\right.$$

We have also examined the barium-salt, which is an amorphous soapy substance. Dried at 100° C., ·2715 grm. gave ·1599 grm. of barium sulphate, corresponding to 34·62 per cent. of barium. Barium œnanthylate contains 34·63 per cent. of barium. We believe amylacetic acid to be identical with œnanthylic acid.

The concluding portion of the paper is devoted to a discussion of the theoretical bearings of the reactions above described, and to the investigation of the internal architecture of the synthetically prepared ethers, acids, and ketones.

RESEARCHES ON THE HYDROCARBONS OF THE SERIES $C_n\,H_{2n+2}$.

By C. Schorlemmer, Esq., Assistant in the Laboratory of Owens College, Manchester.

From my experiments communicated to the Royal Society on the 6th of April, 1865, I concluded that the question, whether only one series of hydrocarbons of the general formula $C_n\,H_{2n}+_2$ exists, or whether this series exhibits cases of absolute isomerism, can only be definitely decided by obtaining from different sources perfectly pure hydrocarbons, having the same composition. But unfortunately only a few of the hydrocarbons can be obtained perfectly pure, and still fewer of these possessing the same composition can be derived from different sources. This is seen by a glance at the following Table, containing those alcohol-radicals and hydrides which have been obtained with certainty in a pure state.

		Boiling-points.		Boiling-points.
$C_2\,H_6$	Methyl.		Hydryde of ethyl.	
$C_4\,H_{10}$	Ethyl.		——	
$C_5\,H_{12}$	——		Hydride of amyl	30°
$C_6\,H_{14}$	Ethyl-butyl	62°	Hydride of hexyl*	69·5
$C_7\,H_{16}$	Ethyl-amyl	90	Hydride of heptyl†	99
$C_8\,H_{18}$	Butyl	108	Hydride of heptyl.	
$C_9\,H_{20}$	Butyl-amyl	132	——	
$C_{10}H_{22}$	Amyl	158	——	
$C_{12}H_{26}$	Hexyl (caproyl)	202	——	

For the purpose of examining the question of the identity or the isomerism of these hydrocarbons, I selected methyl-hexyl and hydride of heptyl, obtained from azelaic acid, comparing the properties of these bodies with ethyl-amyl, as described in my last communication.

(1) *Methyl-hexyl.*

Methyl-hexyl (methyl-caproyl) has already been prepared by Wurtz by the electrolysis of a mixture of acetate and œnanthylate of potassium, but he has obtained it in a small quantity only, and in a very impure state.‡ I adopted the same method, and am able to confirm all that Wurz has stated. Although I employed several ounces of œnanthylate of potassium, only a very inconsiderable quantity of an aromatic oil was obtained, which, in order to isolate the hydrocarbon, C_7H_{16}, was first distilled with concentrated sulphuric acid, by the action of which sulphurous acid was evolved and a black charry matter separated out. The oily distillate was well washed and further purified by means of nitric acid, caustic potash, and sodium, as described in my former papers, and then the small quantity of methyl-hexyl separated by fractional distillation from hexyl $C_{12}H_{26}$, which latter hydrocarbon is formed in by far the greatest proportion.

Methyl-hexyl boils at 89°–92°C., and has the specific gravity 0·6789 at 19° C. The analysis gave the following numbers:—

0·2002 substance gave 0·6150 carbonic acid and 0·2900 water.

	Calculated.	Found.
C_7	84	83·78
H_{16}	16	16·14
	——	——
	100	99.92

The quantity which I obtained was only sufficient for determining the boiling-point and the specific gravity, both of which nearly coincide with those of ethyl-amyl; and although I could not investigate its reactions, I believe that these also will agree with those of ethyl-amyl, so that the two hydrocarbons appear to be identical.

CONTRIBUTIONS TO THE CHEMISTRY OF NATURAL WATERS.

By T. Sterry Hunt, A.M., F.R.S.; of the Geological Survey of Canada.§

Analyses of various Natural Waters.

Sec. 35. The analyses of the various mineral waters to be given in the second part of the present paper, were made according to the modes laid down in the treatise of Fresenius on Quantitative Analysis. The carbonate of soda in the alkaline waters was determined by the excess of the alkaline bases over the chlorine and sulphuric acid present. This was generally controlled by the amount of the carbonate of baryta thrown down from a solution of chlorid of barium by a solution of the soluble salts obtained by the evaporation of the mineral water; and in some cases, to be specified farther on, this latter process was relied on as the only means of determining the amount of carbonate of soda. For remarks on the earthy carbonates of the waters, and their relation to the results of analysis, see Part III of this paper.

The date at which the various waters were collected for analysis is in each case appended to the notice of the spring. This is of the greater importance, inasmuch as it will be shown that, in the course of years, some of the springs here described have suffered considerable changes in their composition.

Sec. 36. In the following table are given the analyses of several waters belonging to the first class, as defined in sec. 34.*

1. This water is from a well thirty feet in depth, near the village of Ancaster, on the western shore of Lake Ontario. It is sunk in the Niagara formation; but like the other waters of this class, probably has its source in the Lower Silurian limestones. The water rises nearly to the surface, but there is no perceptible discharge. Its temperature was found to be 48° F. when collected for analysis in September, 1847.

Table I.—Waters of the First Class.

	1.	2.	3.	4.	5.	6.	7.	8.
Chlorid of sodium ...	17·8280	18·9158	38·7315	17·4000	29·8034	19·94	29·864	7·227
„ potassium ...	·0920	*traces.*	*traces.*	undet.	·3555	und't	undet.	undet.
„ calcium	12·8027	17·5315	15·9230	9·2050	14·8544	6·49	12·439	2·102
„ magnesium .	5·0737	9·5437	12·9060	9·4843	3·3977	1·95	7·333	1·763
Bromid of sodium ...	·1178	·2482	·4685	undet.	undet.	und't	undet.	undet.
Iodid of sodium	....	·0008	·0133	„	·0042	......	„	„
Sulphate of lime ...	·7767	....	....	....	2·1923	1·77	·954	2·388
Carbonate of lime ...	traces.	·0411	....	....	....	......	·370	·400
„ magnesia	....	·0227	....	....	....	......	1·287	....
„ {baryta & stroutia . }	......	undet.	....	....	....	......	....	....
In 1,000 parts	36·6909	46·3038	68·0423	36·0893	50·6075	30·15	52·247	13·880

2 This water is from a copious spring which issues from the limestones of the Trenton group at Whitby, on the north shore of Lake Ontario. It contained small portions of baryta and scrontia, and was collected in October, 1853.

3, 4. Several wells have been sunk in the Trenton limestone in the township of Hallowell, on the Bay of Quinté, Lake Ontario, in search of brine for salt-making, and have yielded bitter saline waters, of which the two here noticed are examples. No. 3 was obtained from a well twenty-seven feet deep, in October, 1853. No. 4 was taken in the summer of 1854 from a well a mile or two distant from the last. Neither of these waters was examined for baryta or strontia.

5, 6. At St. Catherines, near Niagara Falls, a boring of five inches in diameter was carried to a depth of about 500ft., and, after traversing the Medina formation, is said to have penetrated 50ft. or 60ft. into the Hudson River shales. It yields about twenty gallons a minute of a saline water, whose analysis by Professor Croft of the University of Toronto, a few years since, afforded the results given under 5. This water, which was first sought for the manufacture of salt, is now much used for medicinal purposes. Its strength seems subject to some variation, since a specimen from the same well in December, 1861, gave me, by a partial analysis, chlorid of sodium 23·00, chlorid of calcium 9·66, chlorid of magnesium 2·40, sulphate of lime 1·75=36·81 parts in 1,000. No. 6, examined at the same time, is from a second well sunk in 1861, not far from the last.

7, 8. These are analyses of the waters from two borings in the Trenton limestone at Morton's distillery in Kingston. The analyses are by Dr. Williamson of Queen's College in that city, and were made probably ten or twelve years since. They have been recalculated so as to represent the whole of the sulphuric acid as combined with calcium. The first of these waters gave to Dr. Williamson both bromine and iodine, and the second was found to be sulphurous. These waters differ from the preceding in containing considerable amounts of earthy carbonates, and in this respect are related to those of the second class, while they still show a large predomineuce of earthy chlorids.

Sec. 37. The waters of the above table contain, besides chlorid of sodium and a little chlorid of potassium, large quantities of the chlorids of calcium and magnesium, amounting together, in several cases, to more than one half the solid contents of the water. Sulphates either are absent, or occur only in small quantities, and the same is true of earthy carbonates. Salts of baryta and strontia are sometimes present, while the proportions of bromids and iodids, though variable, are often considerable

In the large amount of magnesian chlorid which they contain these waters resemble the bittern or mother-liquor which remains after the greater part of the chlorid of sodium has been removed from sea-water by evaporation. The bitterns from modern seas, however, differ in the presence of sulphates, and in

* Dale, Journ. Chem. Soc. New Ser. ii. p. 258. † Ibid.
‡ Ann. de Chim. et de Phys. 3 sér. xliv. 296.
§ From the American Journal of Science and Arts.

* Of the thirty-seven analyses of waters here given, ten have already appeared in this Journal, [2], viii., ix., xi.; but for the purposes of comparison it is thought well to reproduce them in the present connection. Of the others the greater part have appeared in the "Geology of Canada," but several are now for the first time in print.

containing, when sufficiently concentrated, only traces of lime. The reason of this, as already pointed out in Sec. 22, is to be found in the fact that in the waters of the present ocean the sulphates are much more than equivalent to the lime, so that this base separates during evaporation as gypsum.* But, as shown in Sec. 23 and Sec. 24, the waters of the ancient seas, which held in the form of the chlorid of calcium the greater part of the lime since deposited as carbonate, must have yielded by evaporation bitterns containing a large proportion of chlorid of calcium. Such is the nature of the brines whose analyses are given in the above table, and such we suppose to have been their origin. The complete absence of sulphates from many of these waters points to the separation of large quantities of earthy sulphates in the Lower Silurian strata from which these saline springs issue; and the presence in many of the dolomitic beds of the Calciferous sandrock of abundantly disseminated small masses of gypsum, is an evidence of the elimination of the sulphates by evaporation. The frequent occurrence of crystalline masses of sulphate of strontian in the Chazy and Black River limestones of this region, is also to be noted as another means by which the sulphates were separated from the waters of the Lower Silurian seas. From the proportions of chlorid of sodium, varying from about one-third to more than two-thirds of the solid contents of the above waters, it is apparent that in most cases the process of evaporation had gone so far as to separate a part of the common salt; and thus successive strata of this ancient saliferous formation must be impregnated with solid or dissolved salts of unlike composition. The mingling of these in varying proportions affords the only apparent explanation of the differences in the relative amounts of the several chlorids in waters from the same region, and even from adjacent sources. These differences are seen on comparing the waters from the different wells of St. Catharines, Hallowell and Kingston, with each other.

Sec. 38. The great solubility of chlorid of calcium renders it difficult to suppose its separation from the mother-liquors so as to be deposited in a solid state in the strata. The same remark applies to chlorid of magnesium. It is, however, to be remarked that the double chlorid of potassium and magnesium (carnallite) is decomposed by deliquescence into solid chlorid of potassium and a solution of chlorid of magnesium; and thus strata like those which at Stassfurth contain large quantities of carnallite (Sec. 22) might give rise to solutions of magnesian chlorid. This, however, would require the presence of a large amount of chlorid of potassium in the early seas. It will be observed, by referring to the analyses above given, that the chlorid of magnesium sometimes surpasses in amount the chlorid of calcium, and sometimes, on the contrary, is equal to only one-half or one-fourth of the latter salt. While it is not impossible that the predominance of the magnesian chlorid in some waters may be traced to the decomposition of carnallite, it is undoubtedly in most cases connected with the action of solutions of carbonate of soda, the effect of which, as already pointed out, is to first separate the soluble lime-salt as carbonate, leaving to a subsequent stage the magnesia chlorid. (Sec. 18.) As this reaction replaces the lime-salts by chlorid of sodium, it might be expected that there would be an increase in the amount of the latter salt in the water wherever the magnesian chlorid predominates, did we not remember that evaporation separates it from the water in a solid form; and that the two processes, one of which replaces the chlorid of calcium by chlorid of sodium, while the other eliminates the latter salt from the solution, might have been going on simultaneously or alternately. As the nature of the waters now under consideration shows that the process of evaporation had been carried so far as to separate the sulphate in the form of gypsum, and probably also a portion of the chlorid of sodium in a solid state, it is evident that we have not yet the data necessary for determining the composition of the water of the Lower Silurian ocean, as regards the proportions of the sodium, calcium, and magnesium which it held in solution; and we can only conclude, from these mother-liquors, that the amount of the earthy bases was relatively very large.

Sec. 39. As already remarked in Sec. 22, the mother-liquor from modern sea-water contains no chlorid of calcium, but, on the contrary, large quantities of sulphate of magnesia; the lime in the modern ocean being less than one-half that required to combine with the sulphate present. If, however, we examine the numerous analyses of rock-salt and of brines from various saliferous formations, we shall find that chlorid of calcium is very frequently present in both of them; thus supporting the conclusions already announced in Sec. 24 with regard to the composition of the seas of former geological periods. The oldest saliferous formation which has been hitherto investigated is the Onondaga salt-group of the New York geologists, which belongs to the upper part of the Silurian series, and supplies the almost saturated brines of Syracuse and Salina in New York. These, notwithstanding their great purity, contain small proportions of chlorids of calcium and magnesium, as shown by the analyses of Beck, and the recent and careful examinations of Goessmann. In the brines of that region the solid matters are equal to from 14·3 to 16·7 per cent. and contain on an average, according to the latter chemist, 1·54 sulphate of lime, 0·93 chlorid of calcium, and 0·88 chlorid of magnesium in 100·00; the remainder being chlorid of sodium.†

The nearly saturated brines from the Saginaw valley in Michigan, which have their sources at the base of the carboniferous series, contain, according to my calculation from an analysis by Professor Dubois, in 100·00 parts of solid matters, chlorid of calcium 9·81; chlorid of magnesium 7·61; sulphate of lime 2·20; the remainder being chiefly chlorid of sodium. Another well in the same vicinity gave to Chilton an amount of chlorid of calcium equal to 3·76 per cent.‡ In a specimen of salt manufactured in this region, Goessmann found 1·09 of chlorid of calcium; and in two specimens of Ohio salt, 0·61 and 1·43 per cent. of the same chlorid. The rock salt from the lias of Cheshire, according to Nichol, contains small cavities, partly filled with air, and partly with a concentrated solution of chlorid of magnesium, with some chlorid of calcium.*

Sec. 40. The brines from the valley of the Allegheny River, obtained from borings in the coal formation, are remarkable for containing large proportions of chlorids of calcium and magnesium, though the sum of these, according to the analyses of Lenny, is never equal to more than about one-fourth of the chlorid of sodium. The presence of salts of barium and strontium in these brines, and the consequent absence of sulphates is, according to Lenny, a constant character in this region over an area of 2,000 square miles. (See Bischof, Chem. Geol. i. 377.) A later analysis of another one of these waters from the same region, by Steiner, is cited by Will and Kopp, Jahresbericht, 1861, p. 1112. His results agree closely with those of Lenny. See also the analysis of a bittern from this region by Boyé (this Journal [2], vii. 74).

These remarkable waters approach in character to those of Whitby and Hallowell; but in these the chlorid of sodium forms only about one-half the solid contents, and the proportion of the chlorid of magnesium to the chlorid of calcium is relatively much greater than in the waters from Western Pennsylvania, where the magnesian chlorid is equal only to from one-third to one-fifth of the chlorid of calcium; the proportions of the two being subject in both regions to considerable variations.

In this connection may be cited a water from Bras d'Or, in the island of Cape Breton, lately analysed by Professor How, which contains, in 1,000 parts, chlorid of sodium 4·991, chlorid of potassium 0·650, chlorid of calcium, 4·413, and chlorid of magnesium only 0·638, besides sulphate of lime 0·134, carbonates of lime and magnesia 0·085, with traces of iron-oxyd and phosphates = 10·821. (Can. Naturalist, viii. 370). The analyses of European waters furnish comparatively few examples of the predominance of earthy chlorids.†

Sec. 41. We have already shown in Sec. 38 how the action of carbonate of soda upon sea-water or bittern will destroy the normal proportion between the chlorids of magnesium and calcium by converting the latter into an insoluble carbonate, and leaving at last only salts of sodium and magnesium in solution. A process the reverse of this has evidently intervened for the production of waters like that from Cape Breton and some others noticed by Lersch, in which chlorid of calcium abounds, with little or no sulphate or chlorid of magnesium. This process is probably one connected with the formation of a silicate of magnesia. Bischof has already insisted upon the sparing solubility of this silicate, and he observed that silicates of alumina, both artificial and natural, when digested with a solution of magnesian chlorid, exchange a portion of their base for magnesia, thus giving rise to solutions of alumina; which, being decomposed by carbonates, may have been the source of many of the aluminous deposits referred to in Sec. 9. He also observed a similar decomposition between the solution of an artificial silicate of lime and soluble magnesian salts. (Bischof, Chem. Geology, i. 13, also chap. xxiv.) In repeating and extending his experiments, I have confirmed his observation that a solution of silicate of lime precipitates silicate of magnesia from the sulphate and the chlorid of magnesium; and have found, moreover, that by digestion at ordinary temperatures with an excess of freshly precipitated silicate of lime, chlorid of magnesium is completely decomposed; an insoluble silicate of magnesia being formed, while nothing but chlorid of calcium remains in solution. It is clear that the greater insolubility of the magnesian silicate, as compared with silicate of lime, determines a result the very reverse of that produced by carbonates with solutions of the two earthy bases. In the one case, the lime is separated as carbonate, the magnesia remaining in solution; while in the other, by the action of silicate of soda (or of lime) the magnesia is removed and the lime remains. Hence, carbonate of lime and silicate of magnesia are everywhere found in nature; while carbonate of magnesia and silicate of lime are produced only under local and exceptional conditions. The detailed results of some experiments on this subject are reserved for another place. It is evident that the production from the waters of the early seas of beds of sepiolite, talc, serpentine, and other rocks in which a magnesian silicate abounds, must, in closed basins, have given rise to waters in which chlorid of calcium would predominate.

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* See farther on this point, Bischof, Chem. Geology, i, 413.

† Goessmann. Report on the Brines of Onondaga: Syracuse, 1862 and 1864. Also Report on the Onondaga Salt Co.: Syracuse, 1862.

‡ Winchell: this Journal [2], xxxiv. 311.

* Cited by Bischof, Lehrbuch ii. 1671. The results of the analyses, by Mr. Northcote, of the brines of Droitwich and Stoke in the same region (L. E. and D. Philos, Mag. [4], ix. 32), as calculated by him, show no earthy chlorids whatever, and no carbonate of lime, but carbonates of soda and magnesia, and sulphates of soda and lime. He regarded the whole of the lime present in the water as being in the form of sulphate. If, however, we replace, in calculating these analyses, the carbonate of soda and sulphate of lime by sulphate of soda and carbonate of lime, we shall have, for the contents of these brines, chlorid of sodium, with notable quantities of sulphate of soda, some sulphate of lime, and carbonates both of lime and magnesia—a composition which is more in accordance with the admitted laws of chemical combinations. From these results it would appear that the earthy chlorids which, according to Nichol, are present in the rock-salt of this formation, are decomposed by sulphates in the waters which, by dissolving the salt, give rise to the brines. It is to be regretted that, in many water analyses by chemists of note, the results are so calculated as to represent the co-existence of incompatible salts. Of the association of carbonates of soda and magnesia with sulphate of lime, as in the analysis just quoted, it might be said that I have shown that it may occur in the presence of an excess of carbonic acid. (This Jour. [2], xxviii. 174). By evaporation, however, such solutions regenerate carbonate of lime and sulphates of soda and magnesia; and by the consent of the best chemists, these elements are to be represented as thus combined. But what shall be said when chlorid of magnesium, carbonate of soda, and silicate of soda are given as the constituents of a water whose recent analysis may be found in a late number of the *Chemical News*, or when bi-carbonates of soda, magnesia, and lime are represented as co-existing in a water with sulphates and chlorids of magnesium and aluminium? These errors probably arise from determining in the recent water, or in water not sufficiently boiled, the lime and magnesia which would, by prolonged ebullition, be separated as carbonates, together with portions of alumina, silica, &c. In the subsequent calculation of the analyses these dissolved earthy bases being regarded as sulphates or chlorids, instead of carbonates, there remains an excess of soda, which is wrongly represented as carbonate, instead of chlorid or sulphate of sodium.

† Lersch, Hydro-Chemie, zweite Auflage: Berlin, 1864; *vide* p. 207. This excellent work, which is a treatise on the chemistry of natural waters, in one volume, 8vo., of 700 pages, was unknown to me when I prepared the first part of this essay.

Sec. 42. Of the waters of the second class whose analyses are here given, the first three occur, with many others of similar character, on the south side of the Ottawa river, below the city of that name. The remaining four are on the north side of the St. Lawrence, between Montreal and Quebec, where also similar waters abound. All of these springs rise from the Lower Silurian limestones of the region.

TABLE II.—WATERS OF THE SECOND CLASS.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Chlorid of sodium	11·6660	9·4600	12·2500	11·1400	8·0454	11·7750	11·4968	17·2671	11·5094
„ potassium	·1040	·1040	·0305	·1460	undet.	·0800	·1832	·2409	undet.
„ barium	......	......	......	·0303	......	......	·0019	......	......
„ strontium	......	......	......	·0185	......	......	·0019	......	......
„ calcium	·1364	·0443	·2870	·2420	·0466	·0503	·0718	·6038	·2264
„ magnesium	·2452	·4942	1·0338	·2790	·0856	·3743	·6636	2·0523	·8942
Bromid of magnesium	·0080	·0029	·0238	·0283	undet.	·0342	·0091	·0587	·0273
Iodid of magnesium	·0052	·0017	·0021	·0052	*traces.*	·0039	·0046	·0133	·0183
Sulphate of lime	......	·1929	......	......	......	......	......	......	......
Carbonate of baryta	......	......	......	·0106	......	......	......	......	......
„ strontia	......	......	......	·0137	......	......	......	......	......
„ lime	·0330	·2980	·1264	·4520	·0470	·2160	·3493	·0120	·0180
„ magnesia	·8904	·3629	·8632	·4622	·8354	1·0593	·9388	·7506	·4464
„ iron	·0096	*traces.*	*traces.*	*traces.*	......	·0054	·0145	*traces.*	*traces.*
Silica	·0700	·0225	·0225	·0552	......	·0479	·0865	undet.	undet.
Alumina	*traces.*	undet.	undet.	undet.	......	·0050	·0145	„	„
In 1,000 parts	13·1678	10·9814	14·6393	12·8830	9·0600	13·6513	13·8365	20·9987	13·1400
Specific gravity	1009·39	1008·78	1010·9	1009·42	......	1010·36	1011·23	......	......

1, 2. These two waters are from the township of Plantagenet. The first is known as Larocque's, and the second as the Georgian Spring. These waters were examined in 1849 and 1851. Two other springs have been observed in the same vicinity, one resembling Larocque's spring and containing borates, with a notable proportion of strontia, while the other is an alkaline-saline water of the third class.

3. Caledonia Intermittent Spring. This spring owes its name to the intermitting discharge of carburetted hydrogen which takes place from its waters. It is in the township of Caledonia, not far from Plantagenet, and near three other waters from the same township, to be mentioned in the next class. The water was collected in September, 1847.

4. Lanoraie. This is from the seigniory of Lanoraie. It contains both baryta and strontia, and evolves an abundance of carburetted hydrogen. The water was collected in March, 1851.

5. Is from a copious spring in the seigniory of Berthie, and was collected in July, 1853.

6. Is from the township of Caxton, and yields six or eight gallons of water a minute, besides a great abundance of inflammable gas. The carbonic acid was found to equal 1·126 parts, of which ·651, or more than one-half, is required for the neutral carbonates present. The water was taken from the spring in October, 1848.

7. Is from the seigniory of St. Léon, and is a copious spring which, like the last, disengages inflammable gas. The carbonic acid was equal to 1·224 parts, of which ·651, or not quite one-half, is required for the neutral carbonates found by analysis. The water was collected in October, 1848.

8, 9. These are from two springs in the parish of Ste-Geneviève on the Batiscan River, and are remarkable for the large proportion of iodids which they contain. The first is known as Trudel's spring, and the second is at the ferry opposite to the church. The waters were collected in August, 1853. Several other saline springs occur in the same neighbourhood.

Sec. 43. Of the waters of the third class which follow, the first four rise from the Trenton limestone, and occur on the south side of the Ottawa River, in the vicinity of the first three of the preceding section. The others are from the south side of the St. Lawrence below Montreal.

1, 2, and 3 are waters from Caledonia, and rise about two miles from the spring 1, of the second table. These waters were examined in September, 1847. The first, which is known as the Gas spring, then yielded about four gallons of water a minute, and discharged in the same time about 300 cubic inches of carburetted hydrogen gas, whence its name. At a distance of four or five rods from this, are the second and third springs, known as the Saline and White Sulphur waters, yielding each about ten gallons a minute. The former affords a few bubbles of carburetted hydrogen gas, and is not at all sulphurous, while the latter contained a little sulphuretted hydrogen, equal to somewhat less than a cubic inch to the gallon. The temperature of the three waters was found to be respectively 44·4°, 45°, and 46° F. The carbonic acid in 1,000 parts of the Gas spring was equal to ·705, of which ·356, or a little more than one half, is required for the neutral carbonates present. In the Saline spring there was found ·648 of carbonic acid, being an excess of ·292 over that required to form neutral carbonates: while in the Sulphur spring, which contained in 1,000 parts only ·590 of carbonic acid, ·349 are contained in the neutral carbonates, leaving only ·141 towards the formation of bi-carbonates. For later analyses of these waters see Sec. 46.

4. This, which is known as Gillan's spring, is from the township of Fitzroy, not very far from the last. Its waters were collected in July, 1850.

TABLE 3.—WATERS OF THE THIRD CLASS.

	1.	2.	3.	4.	5.	6.	7.	8.
Chlorid of sodium	6·9675	6·4409	3·8430	6·5325	9·4231	8·4286	4·8234	5·9662
„ potassium	·0309	·0296	·0230	·1160	·1234	·0382	·0610	undet.
Bromid of sodium	·0150	·0169	·0100	·0217	·0126	·0046	undet.	„
Iodid of sodium	·0005	·0014	*traces*	·0032	·0054	·0085	„	„
Sulphate of potash	·0053	·0048	·0183	......	......	......	......	......
Phosphate of soda	......	......	......	·0124	......	......	......	......
Carbonate of soda	·0485	·1762	·4558	·5885	·1705	·3260	1·5416	·6082
„ baryta	......	......	......	*traces.*	·0226	·0123	*traces*	......
„ strontia	......	......	......	„	·0140	·0096	„	·0250
„ lime	·1480	·1175	·2100	·1500	·3540	·3490	·2180	·1440
„ magnesia	·5262	·5172	·2940	·7860	·5433	·3559	·4263	·4756
„ iron	*traces*	*traces*	*traces*	*traces.*	·0048	*traces*	......	*trace*
Alumina	·0044	undet.	·0026	·0040	*traces.*	„	undet.	undet.
Silica	·0310	·0425	·0840	·1330	·0465	·0540	·2120	·1140
In 1,000 parts	7·7773	7·3470	4·9407	8·3473	10·7202	9·5867	7·2823	7·3330
Specific gravity	1006·2	1005·8	1003·7	1006·24	1008·15	1007·7		

5, 6. These two waters are from Varennes, and are about one hundred rods apart. The first is known as the Saline, and the second is called the Gas spring from the large volumes of carburetted hydrogen gas which it disengages. The Saline spring contained in 1,000 parts ·920 of carbonic acid, of which ·451, or nearly one half, is required to form neutral carbonates present. In the Gas spring was found ·792 of carbonic acid, leaving thus ·312 over that required to form neutral carbonates. The waters were collected in October, 1848.

7. This is from Labaie du Febvre, and is known as Courchêne's spring. It evolves small quantities of carburetted hydrogen gas. The water was collected in September, 1852. Several other mineral springs occur in this vicinity

one of them belonging to this class, and others to the second and fourth classes.

8. This water, from the seigniory of Belœil, was collected in 1851.

Sec. 44. We shall now proceed to the springs which, in Sec. 34, have been referred to the fourth class—and begin with three analyses of a mineral water from Chambly. Here, on a plateau, over an area of about two acres, the clayey soil is destitute of vegetation and impregnated with alkaline waters, which in the dry season give rise to a saline efflorescence on the partially dried up and fissured surface. A well sunk here to a depth of eight or ten feet in the clay, which overlies the Hudson River formation, affords at all times an abundant supply of water, which generally flows in a small stream from the top of the well. Small bubbles of carburetted hydrogen are sometimes seen to escape from the water. The temperature at the bottom of the well was found, in October, 1861, to be 53° F., and in August, 1864, to be nearly 54° F. The mean temperature of Chambly can differ but little from that of Montreal, which is 44·6° F., so that this is a thermal water. Another alkaline aud saline spring in the same parish has also a temperature of 53° F. The water of the spring here described has a sweetish saline taste, and is much relished by the cattle of the neighbourhood. Three analyses have been made of its waters, the results of which are here given side by side. The first was collected in October, 1851; the second in October, 1852; and the third in August, 1864, during a very dry season.

	1851.	1852.	1864.
Chlorid of potassium	undet.	·0324	·0182
„ sodium	·8689	·8387	·8846
Carbonate of sodium	1·0295	1·0604	·9820
„ lime	·0540	·0380	·0253
„ magnesia	·0908	·0765	·0650
„ strontia	undet.	·0045	undet.
„ iron	„	·0024	„
Alumina and phosphate	„	·0063	„
Silica	·1220	·0730	·0166
Borates, iodids, and bromids	undet.	undet.	undet.
In 1,000 parts	2·1652	2·1322	1·9917

A portion of barium is included with the strontium salt. The water contains, moreover, a portion of an organic acid, which causes it to assume a bright brown colour when reduced by evaporation. Acetic acid gave no precipitate with the concentrated and filtered water, but the subsequent addition of acetate of copper yielded a brown precipitate of what was regarded as apocrenate of copper. The organic matter of this and of many other mineral springs has probably a superficial origin. The carbonic acid was determined in the third analysis, and was equal in two trials to ·903 and ·905. The neutral carbonates in this water require ·452 parts of carbonic acid.

Sec. 45. In the following table are given the results of the analyses of several other waters, which belong like the last to the fourth class.

TABLE IV.—WATERS OF THE FOURTH CLASS.

	1.	2.	3.	4.	5.
Chlorid of sodinm	·0207	·0347	·3818	·3920	—
„ potassium	·0496	·0076	·0067	·0318	·0169
Sulphate of soda	...	*traces.*	·0215	*traces.*	·0188
„ potash	·0081	...	...	...	·0122
Carbonate of soda	·1340	·1952	·2301	1·1353	·0410
„ lime	·1740	·0710	·0620	undet.	·2480
„ magnesia	·1287	·0278	·0257	„	·0690
Iron, alumina, phosphates	*traces.*	...	...	„	*traces.*
Silica	·0161	·0110	·0245	„	·2060
In 1,000 parts	·5312	·3473	·7523	1·5591	...
In 10,000 parts	...	...	...	...	·6119

1. This spring was met with some years since in constructing a lock on the Richelieu River at St. Ours, and was enclosed in such a way that it is only accessible through a pump, so that it is impossible to determine the amount of water furnished by the spring, or its freedom from admixture. The water was obtained in November, 1852, and is remarkable for the large proportion of potassium salts. 1,000 parts of the water gave of alkalies determined as chlorids 0·2250, of which 0·0565 parts, or 25·11 per cent., were chlorid of potassium. Another trial gave 24·52 per cent., while a portion of the water taken from the spring three weeks earlier gave a large proportion of alkalies, equal to 0·3400 of chlorids, of which 0·0596, or 17·53 per cent., were chlorid of potassium.

2. This spring occurs on the bank of the Jacques Cartier River, a little above Quebec. It is strongly impregnated with sulphuretted hydrogen, and appears to contain a considerable proportion of borates. It was collected for analysis in the summer of 1852.

3. This water is from a spring in the township of Joly, on the opposite side of the St. Lawrence, a few miles south from the last, and, like it, is sulphurous, and affords a strong reaction of boric acid. It was collected for analysis in July, 1853.

4. A small area of marshy ground in the seigniory of Nicolet, near the line of St. Gregoire, is, like the similar tract in Chambly, so impregnated with mineral water as to be destitute of vegetation. The water collected in a small pit, dug in this locality in the autumn of 1853, was yellowish coloured, and alkaline to the taste, and gave by analysis the above results. Several other alkaline springs occur in this vicinity. All of the preceding waters, with the exception of No. 2, which comes out from the Utica slates, rise, like that of Chambly, from the Hudson River formation.

5. This water, unlike the preceding, is that of a large river, the Ottawa, which drains a region occupied chiefly by ancient crystalline rocks, covered by extensive forests and marshes. The soluble matters which it contains are, therefore, derived in part from the superficial decomposition of these rocks, and in part from the decaying vegetation. The water, which was taken at the head of the St. Anne's rapids, on the 9th of March, 1854, before the melting of the winter's snows had begun, had a pale amber-yellow colour from dissolved organic matter, which gave a dark brown hue to the residue after evaporation. The weight of this residue from 10,000 parts dried at 300° F. was ·6975, which after ignition was reduced to ·5340 parts. As seen in the above table, one-half of the solid matters in this water were earthy carbonates, and more than one-third was silica, so that the whole amount of salts of alkaline bases was ·088 (of which nearly one-half is carbonate of soda), while the St. Ours water, which resembles that of the Ottawa in its alkaline salts, contains in the same quantity 4·248, or more than forty-eight times as much. The alkalies of the Ottawa water, equalled as chlorids, ·0900, of which ·0293, or 32·5 per cent., were chlorid of potassium. The results of some observations on the silica aud organic matter of this river water will be given in Part III. It will be observed that, in the above table, the figures given for the first five waters are for 1,000 parts, while those of the Ottawa are for 10,000 parts.

Sec. 46. In this connection may be given the analyses of two similar springs from Vermont, the Highgate and Alburg springs. The waters were sent me in October and November, 1861, and the results have already appeared in the "Geology of Vermont," vol. ii., p. 926. Both of these waters, when examined, were slightly sulphurous, and yielded the reactions of boric acid. The amount of carbonate of soda was estimated from the carbonate of baryta obtained by the process already mentioned in Sec. 35.

	Highgate.	Alburg.
Chlorid of sodium	·402	·140
Sulphate of soda	·042	·024
Carbonate of soda	·235	·230
„ lime	·024	·036
„ magnesia	·010	·022
Potash and borates	undet.	undet.
In 1,000 parts	·713	·452

Sec. 47. On the 5th January, 1865, after a lapse of more than seventeen years, I again visited the three springs of Caledonia, whose analyses have been given in the table, sec. 43, and collected their waters for a second examination. The results of my recent analyses show that considerable changes have occurred in the composition of each of these springs, and tend to confirm in an unexpected manner, the theory which I long since put forward, that the waters of the second and third classes owe their origin to the mingling of saline waters of the first class with alkaline waters of the fourth class. It will be observed that the three Caledonia waters in 1847 were all alkaline, though the proportions of the carbonate of soda were unlike. Sulphates were also present in all of them, though most abundant in the sulphur spring, which, although holding the smallest amount of solid matters, was the most alkaline. In January, 1865, however, the first and second of these waters had ceased to be alkaline, and contained, instead of carbonate of soda, small quantities of earthy chlorid, causing them to enter into the second class. They no longer contained any sulphates, but, on the contrary, portions of baryta and strontia. Only the Sulphur spring, which in 1847 contained the largest proportion of carbonate of soda and of sulphates, still retained these elements, though in diminished amounts, and was feebly impregnated with sulphuretted hydrogen. If we suppose these waters to arise from the commingling of saline waters like those of Whitby and Lanoraie, containing earthy chlorids and salts of baryta and strontia, with waters of the fourth class holding carbonate and sulphate of soda, it is evident that a sufficient quantity of the latter water would decompose the earthy chlorids and precipitate the salts of baryta and strontia present; while an excess would give rise to alkaline-saline waters containing sulphate and carbonate of soda, such as were the three springs of Caledonia in 1847. A falling-off in the supply of the sulphated alkaline water has however taken place, and the result is seen in the appearance of chlorid of magnesium and of baryta and strontia in two of the springs, and in a diminished proportion of carbonate of soda in the Sulphur spring.

These later analyses being directed chiefly to the determination of these changes, no attempt was made to determine potassium, iodine, and bromine. For the purposes of comparison, the two series of analyses are here put in juxtaposition; the elements just mentioned being included with the chlorid of sodium, and the figures reduced to three places of decimals. The precipitate by a solution of gypsum from the concentrated and acidulated water was regarded as sulphate of strontia, and calculated as such, but was in part sulphate of baryta.

In the recent analyses of these waters, the carbonic acid in the Gas spring was found to equal, for 1,000 parts, ·671; of which ·278 were required for the neutral carbonates. The Saline spring contained ·664 of carbonic acid, of which ·290 go to make up the neutral carbonates. The Sulphur spring, in like manner, gave of carbonic acid ·573, while the neutral carbonates of the water require only ·191. All of these waters in January, 1865, thus contained an excess of carbonic acid above that required to form bicarbonates with the carbonated bases present; while the analyses of the same springs in 1847 showed, as we have seen in sec. 43, a quantity of carbonic acid insufficient for the formation

of bicarbonates. The questions of this deficiency, and of the variation in the amount of carbonic acid in these and other waters will be considered in the third part of this paper.

Table V.—Showing the changes in the Caledonian Springs.

	1. Gas spring.		2. Saline spring.		3. Sulphur spring.	
	1847.	1865.	1847.	1865.	1846.	1865.
Chlorid of sodium	7·014	6·570	6·488	6·930	3·876	3·685
„ magnesium.........	....	·024	....	·026	—	—
Sulphate of potash	·005	....	·005	....	·018	·021
Carbonate of soda...............	·048	....	·176	....	·456	·091
„ lime...............	·148	·096	·117	·095	·210	·077
„ magnesia	·526	·455	·517	·469	·294	·228
„ strontia	....	·009	....	·012	—	—
Silica	·021	·020	·042	·015	·084	·021
In 1,000 parts	7·762	7·174	7·345	7·547	4·938	4·123

Sec. 48. The waters of our fifth and sixth classes, as defined in sec. 34, are distinguished by the preseuce of sulphates; the former being acid and the latter being neutral waters. In the fifth class the principal element is sulphuric acid, associated with variable and accidental amounts of sulphates of alkalies, lime, magnesia, alumina, and iron. Apart from the springs of this kind which occur in regions where volcanic ageucies are evidently active, the only ones hitherto studied are those of New York and western Canada, which issue from unaltered, and almost horizontal Upper Silurian rocks. (Sec. 31.) The first accouut of these remarkable waters was given in this journal in 1829 (vol. xv. p. 238), by the late Prof. Eaton, who described two acid springs in Byron, Genesee Co., N. Y.; one yielding a stream of distinctly acid water sufficient to turn a mill-wheel, and the other affording in smaller quantities a much more acid water. The latter was afterwards examined by Dr. Lewis Beck (Mineralogy of New York, p. 150). He found it to be colourless, trausparent, and intensely acid, with a specific gravity of 1·113; which corresponds to a solution holding seventeen per cent. of oil of vitriol. No chlorids, and only traces of lime and iron, were found in this water, which was nearly pure dilute sulphuric acid. Prof. Hall (Geology of New York, 4th District, p. 134), has noticed in addition to these several other springs and wells of acid water in the adjacent town of Bergen. Farther westward, in the town of Alabama, is a similar water, whose analysis by Erni and Craw will be found in this journal [2], ix. 450. It contained in 1,000 parts about 2·5 of sulphuric acid, and 4·6 parts of sulphates, chiefly of lime, magnesia, iron, and alumiua. In this, as in the succeeding analyses, hydrated sulphuric acid, SO_3HO, is meant.

The earliest quantitative analyses of any of these waters were those by Croft and myself of a spring at Tuscarora, in 1845 and 1847, of which the detailed results appear in this journal [2], viii. 364. This, at the time of my analyses in September, 1847, contained, in 1,000 parts, 4·29 of sulphuric acid, and only 1·87 of sulphates; while the previous analysis by Prof. Croft gave approximately 3·00 of neutral sulphates, and only about 1·37 of sulphuric acid. Similar acid waters occur on Grand Island above Niagara Falls, and at Chippewa.

All of these springs, aloug a line of more than 100 miles from east to west, rise from the outcrop of the Onondaga salt-group; but in the township of Niagara, not far from Queenston, are two similar waters which issue from the Medina sandstone. One of these is iu the southwest part of the township, and fills a small basin in yellow clay, which, at a depth of three or four feet, is underlaid by red and green sandstones. The water, which like those of Tuscarora and Chippewa, is slightly impregnated with sulphuretted hydrogen, is kept in constant agitation from the escape of iuflammable gas. It contained in 1,000 parts abont two parts of free sulphuric acid, and less than one part of neutral sulphates. This water was collected in October, 1849, and at that time another half dried-up pool in the vicinity contained a still more acid water. Another similar spring occurs near St. Davids, in the same township.

In connection with the suggestion made in Sec. 31 as to their probable origin at great depths, it would be very desirable to have careful observations as to the temperature of these acid springs. When, on the 19th October, 1847, I visited the Tuscarora spring, the water in two of the small pools had a temperature of 56° F.; but on plunging the thermometer in the mud at the bottom of one of these it rose to 60·5°.

Sec. 49. It appears from a comparison of the analysis of Croft with my own, that the waters of the Tuscarora spring underwent a considerable change in composition in the space of two years; the proportion of the bases to the acid at the time of the second analysis being little more than one-third of that in the analysis of Croft. This change was indeed to be expected, since waters of this kind must soon remove the soluble constituents from the rocks through which they flow, and eventually become like the water from Byron, little more than a solution of sulphuric acid. The observations of Eaton at Byron, and my own at Tuscarora, show that half-decayed trees are still standing on the soil, which is now so impregnated with acid waters as to be unfit to support vegetation. Reasoning from the changes in composition, it may be supposed that these waters were at first neutral, the whole of the acid being saturated by the calcareous rocks through which they must rise. It was from this consideration that I was formerly led to ascribe to the action of these waters, the formation of some of the masses of gypsum which appear along the outcrop of the Onondaga salt-group. (This journal [2], vii. 175.) That waters like those just mentioned must give rise to sulphate of lime by their action on calcareous rocks is evident; and some of the deposits of gypsum in this region, as described by good observers, would appear to be thus formed. So far, however, as my personal observations of the gypsums of Western Canada have extended, they appear to be in all cases contemporaneous with the shales and dolomites with which they are interstratified, and to have no connection with the sulphuric acid springs which are so common throughout that region. (This journal [2], xxviii. 365, and Geology of Canada, 352.)

Sec. 50. We have included in a sixth class the various neutral saline waters in which sulphates predominate, sometimes to the exclusion of chlorids. The bases of these waters are soda, potash, lime, and magnesia; which are usually found together, though in varying proportions. For the better understanding of the relations of these sulphated waters, it may be well to recapitulate what has been said about their origin; and to consider them, from this point of view, under two heads.

First, those formed from the solution of neutral sulphates previously existing in a solid form in the earth. Strata enclosing natural deposits of sulphates of soda and magnesia, sometimes with sulphate of potash (Secs. 17 and 19), afford the most obvious source of these waters. The frequent occurrence of gypsum, however, points to this salt as a more abundant source of sulphated waters. Solutions of gypsum may in some cases exchange their lime for the soda of insoluble silicates, or this salt may be decomposed by solutions of carbonate of soda (Secs. 7 and 19). The decomposition of the sulphate of lime by hydrous carbonate of magnesia, as explained in Sec. 21, is doubtless in many cases the source of sulphate of magnesia, which is, more frequently than sulphate of soda, a predominant element in mineral waters. In connection with a suggestion made in the section last cited, it may be remarked that I have since found that predazzite, in virtue of the hydrate of magnesia which it contains, readily decomposes solutions of gypsum holding carbonic acid in solution, and gives rise to sulphate of magnesia.

In the second place, sulphuric acid waters, like those described in Sec. 47, by their action upon calcareous and magnesian rocks, or by the interventiou of carbonate of soda, may, as already suggested, give rise to neutral sulphated waters of the sixth class. It is evident, also, that waters impregnated with sulphates of alumina and iron from oxydising sulphates, as mentioned in Sec. 28, may be decomposed iu a similar manner, and with like results.

Neutral sulphated waters generated by any of the above processes are evidently subject to admixtures of saline matters from other sources, and may thus become impregnated with chlorids and carbonates. Iudeed, it is rare to find waters of the sixth class without some portion of chlorids, and a transition is thus presented to the waters of the first four classes; in which, also, portions of sulphates are of frequent occurrence. The presence of sulphates being one of the conditions required for the generation of sulphuretted hydrogen (Sec. 10), we find that the waters of the sixth class are very often sulphurous.

Sec. 51. Waters of the sixth class are very frequently met with in the Paleozoic rocks of New York and Western Canada, and are probably derived from the gypsum which is found in greater or less abundance at various horizons, from the calciferous sandrock to the Onondaga salt-group. It is, however, not improbable that the sulphuric acid waters which abound in this region (Sec. 48), may, by their neutralisation, give rise to similar springs. In the waters of the district under consideration, the sulphate of lime generally predominates over the sulphates of the other bases, and chlorids are frequently present in considerable quantities. For uumerous analyses of these waters, see Beck, Mineralogy of New York. The results of an examination of the Charlotteville spring, remarkable for the amount of sulphuretted hydrogen which it contains, will be found in this Journal [2], viii., 369. A very copious sulphur spring which issues from a mound of calcareous tufa in Brant, C.W., overlying the Corniferous limestone, is distinguished by the absence of any trace of chlorids; in which respect it resembles the acid waters of the fifth class from the adjacent region. A partial analysis of a portion of it collected in 1861, gave, for 1,000 parts, sulphate of lime 1·240, sulphate of magnesia ·207, and carbonate of lime ·198. From a slight excess in the amount of sulphuric acid, it is probable that a little sulphate of soda was also present.

Of waters of this class, in which sulphate of magnesia predominates, but few have yet been observed in this country. A remarkable example of this kind from Hamilton, C.W., was examined by Professor Croft, of Toronto, and described by him in the Canadian Journal for 1853 (page 153). It had a specific gravity of 1006·4, and gave for 1,000 parts—

Chlorid of sodium	·5098
Sulphate of soda	1·6985
„ lime	1·1246
„ maguesia	4·7799
	8·1128

The rocks exposed at Hamilton iuclude the Medina sandstone, and the Niagara limestone, with the intermediate Clinton group. Along the outcrop of the latter, crystalline crusts of nearly pure sulphate of magnesia are observed to form in many localities, during the dry season of the year. (Geology of Canada, p. 460.)

According to Emmons, the post-tertiary clays near Crowu Point, on the western shore of Lake Champlain, are, during dry weather, covered with efflorescences of sulphate of magnesia, which impreguates several springs in the vicinity. The water of one of these, according to Emmons, had a specific gravity of 1014·0, and coutained, in 1,000 parts 18·78 of saline matter, which was chiefly sulphate of magnesia, with some sulphate of lime. (Cited by Beck,

Mineralogy of New York, p. 252.) The strata underlying the clays of this region belong, according to the State geological map, to the Potsdam, Calciferous, and Trenton formations, but the source of the magnesian salt is not improbably to be found in the clays themselves.

In the third and concluding part of this paper, it is proposed to notice briefly some of the more important points in the chemistry of the various waters which have been here described, and to inquire into their geological relations.

IRON-CASED SEAGOING TURRET VESSEL.

The possibility of constructing armour-clad ships of moderate size, to carry heavy guns without sacrificing speed and seagoing qualities, has been repeatedly discussed in Parliament and elsewhere, and is a question that is occupying the attention of all who are interested in the development of our naval resources and the construction of the ironclad fleets of the future.

Messrs. Laird Brothers, of Birkenhead, have just completed a vessel which, from her performance on trial and general appearance, bids fair to fulfil these conditions. She is an iron vessel of 1,100 tons and 300 horse-power, with a speed of more than twelve knots an hour on a draft of water of 16ft., throwing a weight of broadside of 600lbs. from her turret, besides carrying two 40-pounder rifled guns on the quarter deck. The dimensions of the hull are about 200ft. extreme length, 35ft. breadth, 20ft. deep, and 1,100 tons measurement. The hull is of iron of great strength, and is divided internally by bulkheads into watertight compartments, so as to enclose her turret, engines, boilers—all her vital points, in fact—in separate compartments. In addition to this provision for the ship's security, there is a double bottom under the engines, boilers, turrets, and magazines, extending up to the lower deck. The armour plating is 4½in. thick, extending from her upper deck to 3½ft. below the load water line, slightly tapering towards the bow and stern, to lessen the tendency to pitch in a seaway, and rests on teak backing 10in. thick. The accommodation for the officers and crew is of a very superior description, well ventilated by means of skylights and side scuttles, and there is free communication from one end of the ship to the other by iron sliding doors on all the watertight bulkheads. The spaces in the store room and magazines are ample for the stowage of six months' provisions and ammunition. The turret is cylindrical in shape, covered with armour plates 5½in. thick, and is placed before the engine room, and is fitted with slides and carriages for two 12½-ton 300-pounder guns on the system of Captain Cowper P. Coles, R.N. The rig of the ship is that of a brig, the foremast being fitted as a tripod, on Captain Coles' patent, to give greater range of training to the guns in the turret. The engines of the ship are 300 horse-power nominal, having cylinders 54in. diameter, 3ft. stroke, driving a four-bladed screw propeller, 14ft. 9in. diameter, 17ft. 9in. pitch. The cylinders have steam jackets and improved expansion valves. The trials of speed were made at the measured mile, and gave, as the result of four runs, a speed of 12·27 knots an hour. At the time of these trials the vessel was completed in every way except guns and sea stores, and had 100 tons of coal in the bunkers. The mean draft of water was 14ft. 3in., the engines made seventy-eight revolutions; pressure of steam 25lbs., vacuum 26in., indicated horse-power 1,650. The engines worked very well, and the boilers gave an abundant supply of steam. The ship was quick in answering her helm, and her steering arrangements are excellent, having one wheel in front of the poop and the second under the pilot tower forward.

This, we believe, is the greatest speed ever attained by an ironclad vessel of this size, and bears out the statement made by Mr. Laird in the House of Commons, in the discussion on naval estimates in March last, that it would be possible to build vessels of this class to have a speed of twelve knots an hour; and the recommendation of Mr. Stansfeld, M.P., that the Government should seriously consider the importance of constructing small fast vessels, carrying one or two heavy guns, at a high rate of speed, as, in his opinion, tending to increase our means of defence, and keep down the costliness of the naval service of the country.

Obituary.

MR. NICHOLAS WOOD.

We regret to announce the death, on the 19th ult., of Mr. Nicholas Wood, the contemporary of George Stephenson. Mr. Wood was doubtless well known to most of our readers as an eminent engineer; additional interest was centered in him, as it had fallen to his lot to afford assistance to George Stephenson, and at a very early period in his career, when working in the Killingworth Colliery, of which Mr. Wood was then (1815) the head viewer. Stephenson was indebted to Mr. Wood for the friendly and useful assistance received at his hands in the designing of a miner's safety lamp, which was proved to be a success, and the "Geordie" lamp obtained general use in the Killingworth pits. Mr. Wood was, after this, engaged in conjunction with Stephenson, in making a series of experiments on the resistance to which carriages were exposed on railways, testing the results by means of a dynamometer of Stephenson's own construction, and by means of which it was, for the first time, ascertained that the friction was a constant quantity of all velocities. Stephenson, after leaving school at Newcastle, was put apprentice to Mr. Wood, whilst that gentleman was head viewer at Killingworth, to learn the business of the colliery. About the end of the year 1821, Mr. Wood and Mr. Stephenson were introduced to Mr. Pease at Darlington. They had heard of the passing of the Stockton and Darlington Act, and Stephenson had for some time previously directed his attention to the construction of locomotive engines. How this interview ended is well known to most of our readers, inaugurating, as it did, the development of our national railway system. That Mr. Wood, however, did not possess, the same sanguine expectation as Stephenson did, in regard to the success of the power of the locomotive, is shown by a communication which he wrote in the year 1825. "It is far from my wish," he said, "to promulgate to the world that the ridiculous expectations, or rather professions, of the enthusiastic speculator will be realised, and that we shall see engines travelling at the rate of twelve, sixteen, eighteen, or twenty miles an hour. Nothing could do more harm towards their general adoption and improvement than the promulgation of such nonsense." Perhaps it is this feeling of caution which, more than any other principle, has at all times been the prominent feature of his character. There has been scarcely a railway constructed in the North of England but in which Mr. Wood's opinion has been sought, and regarding which he has been called upon to give evidence before committees in the Houses of Parliament. Amongst these, the decisions arrived at when the Sunderland Dock and other local schemes were before the House, were affected in no small degree by his testimony. Of late years Mr. Wood has resided in Hetton, where, being more personally known, he was greatly respected. Occasionally he visited Newcastle, on matters of business, and in connection with the Northern Institute of Mining Engineers, an association in which he took very great interest. In token of the high esteem entertained for him by the inhabitants of the neighbourhood, a public dinner was given to Mr. Wood at Hetton-le-Hole, on the 20th of February, 1856. The chair was taken by the Rev. J. S. Nicholl, and upwards of 160 gentlemen were present. For the past few months, owing to advancing years, his health became less vigorous, and, while on a visit to London, consulting with a medical gentleman, his illness, which had been of a protracted character, assumed a serious form, and terminated fatally, on December 19th. Deceased was in his 71st year.

MR. ALAN STEVENSON.

We regret to announce the death, on the 23rd ult., at Portobello, near Edinburgh, of Mr. Alan Stevenson, lighthouse engineer, in his 59th year, who has at last succumbed to the effects of his many years of suffering.

The deceased engineer was the eldest son of the late Robert Stevenson, the well known civil engineer and author of the Bell Rock Lighthouse, was born at Edinburgh in 1807. He was educated at the High School and University, where he greatly distinguished himself, and took the then somewhat unusual degree of Master of Arts, and obtained under Leslie the Fellowes Prize for excellency as an advanced student of Natural Philosophy. He afterwards studied in England under the direction of a clergyman, and received the degree of Bachelor of Laws from the University of Glasgow. His own wish was to study for the Church, but he gave it up for his father's profession—in which he soon made himself a name. Though obliged by illness to retire from work when in the fulness of his years and powers, the services he performed as Engineer to the Commissioners of Northern Lighthouses were such as to entitle him to lasting remembrances in the annals of our highest scientific achievements—in a department at once so perilous, difficult in nature, and so inestimable in its results. During his connection with the Board, he introduced

many improvements in the Dioptric system of illumination, and erected numerous lighthouses on our coasts, including his masterpiece, the renowned Skerryvore, which breasts the mighty fetch of the Atlantic, which, whether we regard the beauty of its design, its magnitude, the perfection of the work, or the difficulties of its beginning, may safely be said to be unsurpassed by any similar structure in the world. Its rise and progress may be read in the animated words of its originator and executor, forming a volume only second in interest to that of his honoured father on the Bell Rock, which is the very romauce of stone aud lime.

There is little doubt that the mental tension caused by the responsibilities and difficulties of this work, acting upon his sensitive, chivalrous, aud unspariug nature, was the main cause of the sudden shattering of his nervous system, which in 1852 made it necessary for him to withdraw absolutely from his profession and the world. What a trial this must have been to one of his keen, intrepid temper, his high enthusiasm, and his delight in the full exercise of his powers, no one but himself and those who never left him for these long, dreary years can ever tell—when his mind, his will, his affections survived, as it were, the organ through which they were wont to act—like one whose harp is all unstrung, and who has the misery to know it can do his bidding no more.

Besides his purely professional excellences, Mr. Stevenson had genuine literary genius—not receptive merely, but in the true sense original.

He had in everything he did that grace and delicacy, that perception of spiritual depth and height, that sense of a beauty, transcending all adequate expression, and that tender, pervading melancholy which are among the bitter-sweet birthrights of genius. This, however, is not the place for expatiating on that characteristic part of his nature.

Mr. Stevenson read Italian and Spanish critically and with ease, and knew both literatures thoroughly. He knew Homer by heart; and read Aristophanes in Greek more readily than most of us could read Montaigne in French.

The late Mr. Stevenson printed during the past year, a little volume for private circulation, entitled, "The Ten Hymns of Synesius, Bishop of Cyrene, A.D. 410, in English verse," &c., which he thus speaks of in his preface :—"It pleased God in 1852 to disable me by a severe nervous affectiou for my duties as engineer to the Board of Northern Lighthouses; and I took to beguiling my great sufferings by trying to versify the whole ten hymns of Synesius. Duriug mauy an hour the employment helped to soothe my pain."

It is quite wonderful, if we consider the nature of the task, and his broken health, how nobly he has rendered those sublime old hymns, in which we find the doctrine of the pre-existence of the soul so glorified in Wordsworth's "Intimations of Immortality," aud with which the heavenly-minded Leighton refreshed himself, and eight of which were translated by Coleridge into English anacreontics, before that strange and mournful prodigy had reached his fifteenth year.

In this little volume there are some occasional pieces of his own full of himself—his godliness, his tender love, his quaint learning, his all-pervading fineness of thought and touch.

The following is an extract from his sonnet, "To the Ringiug-Stone at Balaphetrish, in the island of Tyree" where his building depot for Skerryvore was. It has a son's likeness to Wordsworth :—

"Mysterious Stone! rude, shapeless as thou art,
Thou seem'st unconscions of the ocean's rage,
Or winter tempests that for mauy an age
Have howled around thee; say, hast thou a heart,
Deep prisou'd in thy mass, that feels the smart
Of other's woes—woes of the geutler kiud,
Which spring up easily in woman's mind?
For, touched by maiden's hand, with gentle art,
Thou givest sighs, that tremble on the breeze,
Which sweep around the western Hebrides,
Such as Audromeda, from ocean's cave,
Might breathe responsive to some sorrowing maid
Whom slighted vows or dear hopes long delayed
Have driven to seek, near thee, a louely ocean-grave."

Mr. Stevenson was a Fellow of the Royal Society, a member of the Institute of Civil Engineers; and had medals presented to him by the Emperor of Russia and the Kings of Prussia and Holland, in acknowledgment of his great merits in lighthouse engineering. When his health gave way, he resigned as a Fellow of the Royal Society of Edinburgh, but from the respect in which he was held, the Council declined to accept his resignation, and continued to him the privileges of his Fellowship. His most important work was his "Account of the Skerryvore Lighthouse, with Notes on the Illumination of Lighthouses" (4to, A. and C. Black, 1848). He was also author of a biographical sketch of the late Robert Stevenson (Blackwood, 1861); "History, Construction and Illumination of Lighthouses" (Weale, London, 1850). He was a contributor to the "Encyclopædia Britannica" and the "Edinburgh Philosophical Journal."

PRICES CURRENT OF THE LONDON METAL MARKET.

	Dec. 2.			Dec. 9.			Dec. 16.			Dec. 23.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selceted, per ton	119	0	0	119	0	0	119	0	0	109	0	0
Tough cake, do.	116	0	0	116	0	0	116	0	0	106	0	0
Copper wire, per lb.	0	1	2¼	0	1	2¼	0	1	2¼	0	1	1¾
„ tubes, do.	0	1	3¼	0	1	3¼	0	1	3¼	0	1	2¼
Sheathing, per ton	121	0	0	121	0	0	121	0	0	111	0	0
Bottoms, do.	126	0	0	126	0	0	126	0	0	116	0	0
IRON.												
Bars, Welsh, in Londou, per ton	7	12	6	7	12	6	7	10	0	7	10	0
Nail rods, do.	8	15	0	8	15	0	8	15	0	8	15	0
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	12	6	8	12	6	8	12	6	8	12	6
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	2	18	6	2	19	6	2	19	6	2	19	6
LEAD.												
English pig, ord. soft, per ton	21	10	0	21	10	0	21	10	0	21	10	0
„ sheet, do.	20	0	0	21	10	0	21	15	0	21	5	0
„ red lead, do.	22	0	0	22	0	0	23	10	0	23	10	0
„ white, do.	26	0	0	26	0	0	27	0	0	27	0	0
Spanish, do.	20	0	0	20	0	0	22	10	0	22	10	0
BRASS.												
Sheets, per lb.	0	1	0½	0	1	0½	0	1	0½	0	0	11¾
Wire, do.	0	1	0	0	1	0	0	1	0	0	0	11¼
Tubes, do.	0	1	1¼	0	1	1¼	0	1	1¼	0	1	0½
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	12	0	1	12	0	1	11	6	1	13	0
IX „ „ „	1	18	0	1	18	0	1	17	6	1	19	0
IC „ 2nd qua., „	1	9	6	1	9	6	1	9	0	1	11	0
IC Coke, per box	1	6	0	1	6	0	1	6	0	1	7	0
IX „ „	1	12	0	1	12	0	1	12	0	1	13	0

REVIEWS AND NOTICES OF NEW BOOKS.

We are compelled, from want of space, to defer giving our Notices and Reviews of New Books uutil next month.—ED. ARTIZAN.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

BRITISH RAINFALL.

To the Editor of THE ARTIZAN.

SIR,—I have to ask your readers' attention for a few moments to a request on the above subject, the importance of which in relation to engineering and drainage questions is well known. It is now some years since I began collecting returns of the fall of rain—with what success I will mention presently—but my main difficulty has been to find out the persous who keep such records, and one of the most obvious sources of assistance is the public press. I now, therefore ask from each and every journal in the British Isles their all-powerful aid. When the collecfion was organised in 1860, scorcely 200 persons were known to observe and record the rainfall; by a steady perseverance, and the aid of a portiou of the press, the number has been raised until there are uow more than 1200 places whence returus are regularly received. Still I know there are many more, probably hundreds, who have either never heard of the establishment of a ceutral depot to which copies of all rain records should be sent, or they have been to diffident to send them. It is of paramount importance to gather these, and make the tables yet more complete. I therefore beg leave through your columns to ask every reader to think for a moment if he or she knows of auy one who keeps, or has kept, a rain-guage, or who has any tables of raiufall (or old weather journals) iu their possession. Aud if they do know of such persons, I ask them on behalf of science, of my fellow observers, aud on my own behalf, to use every effort to secure their assistauce, and to favour me with their names and addresses. We waut old records, we want records for the present year, aud from many parts of the country we want returns for the future, if a few persons will notify to me their willingness to assist, and to pay 10s. 6d. for the very cheap and simple guage now supplied.

To preveut needless correspondence, I annex a list of the places in Middlesex, whence returns have been already collected for the years mentioned in the last column, and shall be very glad of any additions or corrections. Other counties, or the complete list for the whole country shall be sent to any one willing to make good use of it. I may add that an influential committee of the British

Association has been appointed to superintend and assist in my investigations, and that they cordially support my present application.

I am, Sir, your obedient servant,
G. J. SYMONS.
136, Camden-road, London, N.W.

The committee consists of J. Glaisher, Esq., F.R.S., Lord Wrottesly, F.R.S., Prof. Phillips, F.R.S., Prof. Tyndall, F.R.S., Dr. Lee. F.R.S., J. F. Bateman, Esq., F.R.S., R. W. Mylne, Esq., F.R.S., and myself.

Station.	Elevation.	Observer.	Period.
Camden Town	100	G. J. Symons, Esq.	C 1858-
Chiswick	...	Royal Hort. Soc.	1825-
Colney Hatch	...	R. G. Rose, Esq.	1857-
Edmonton	...	C. H. Adams, Esq.	1792-96
„	...	„	1811, 1816-40
„ (Lower)	...	Mr. J. Brown	C 1860-
Enfield (Bush Hill)	89	W. Mylne, Esq.	1864-
„ (Vicarage)	110	Rev. J. M. Heath	1849-
Finchly-road	270	G. W. Moon, Esq.	C 1860-61 T
„	306	„	C 1860-61 T
Hackney	40	Dr. Tripe	1856-58, 1860-
Hammersmith	12	F. J. Burge, Esq.	1856-58, 1860-
Hampstead	360	R. Field, Esq.	C 1862-
Harrow-on-the-Hill	375?	Dr. Hewlett	1864-
Highgate	394	J. Cutbush, Esq.	C 1862-
London (Bryanstone-square)	93	C. O. F. Cator, Esq.	1861-
„ (Chiswell-street)	...	W. Fletcher, Esq.	1850-59, 1861-
„ (Crane-court)	...	Roy. Soc. Trans.	1729-35
„ (Gray's Inn-road)	55	Mr. Strachan	C 1862 T
„ (Guildhall)	50	W. Haywood, Esq.	C 1857-
„ („)	123	„	C 1857-
„ (Hatton Garden)	...	Mr. R. C. Woods	1838 imp.
„ (Mile End)	...	F. Charrington, Esq.	C 1862-
„ (Offord-road)	90	Mr. Strachan	C 1864-
„ (Somerset House)	150	Philos. Trans.	1774-81, 1787-1809,
„ („)	...	„	1812-27, 1829-42 T
„ (Spring Gardens)	36	J. W. Bazalgette, Esq.	1863
„ („)	95	„	1863
„ („)	95	„	1863
„ (Temple Bar)	...	Bent's Met. Journ.	1795-1807
„ (Westminster Abbey)	...	Dr. Heberden	1766-67 imp.
„ („ House)	65?	„	1766-67 imp.
„ („ Garden)	25?	„	1766-67 imp.
„ (Whitehall)	...	J. C. Haile, Esq.	C 1854-60
„	...	Nicholson's Journ.	1808-10
„	...	....	1817-21
„	...	Lady Bayning	1836-42 imp.
Notting Hill	...	S. B. Blunt, Esq.	C 1865-
Paddington	...	....	1854-56
Poplar	25	Mr. Gaster	C 1862-63 T
St. John's Wood (Lit. Soc.)	161	H. J. Montague, Esq.	1857-
„ (Melina-place)	...	G. Leach, Esq.	1852-57 imp.
Spring Grove	70	T. E. Wyatt, Esq.	C 1864-
Tottenham (Vicarage)	...	Rev. J. S. Winter	C 1861-62 T
„	60	— Fowler	1842-45
„ (Lordship-lane)	...	W. D. Howard, Esq.	1847-
Twickenham (Observatory)	24	A. Wiss, Esq.	C 1863-
Uxbridge (Harefield-park)	...	W. Vernon, Esq.	C 1864-
Winchmore Hill	...	Mrs. Feltham	C 1858-

NOTICES TO CORRESPONDENTS.

A. C. (Wilts.)—It is more satisfactory to work pumping engines with a stand-pipe (pumping over it) than with an air vessel. In the former case the load is more uniform.

L. M. (Hereford).—The rollers used for flattening the wire used in the manufacture of gold lace are of hardened steel. The flattened wire is about 1-32 inch wide, being 1-20 gold overlaid on 19-20 silver. The rollers may be polished with emery, crocus and putty powder, applied by means of a lap, made of 1 antimony to $9\frac{1}{2}$ lead.

WILSON.—We believe the tractive resistance of trains on the underground railway has been found to reach 23lbs. per ton. The commonly accepted factor for railways above ground is 10lbs. per ton. Some authors have given it as 7lbs. but that is too low.

TYRO.—The load on any bar of a lattice girder being known, the strain may be found by multiplying the load by the length of the bar and dividing by the depth of the girden at the point of junction with the bar; thus

Let the load = 10 tons
depth of girder = 5 feet
length of lattice bar = 7 feet
the strain on that bar will be

$$= 10 \times \frac{7}{5} = 14 \text{ tons.}$$

MAXWELL.—The camber given to straight girders is too small to effect the distribution of strain in the various parts. You can calculate the strains as for a mathematically straight beam.

B. M.—You may take the strength of the rivetted joints as 56 for single rivetting and 70 for double, the solid plate being 100.

W.H.W. (Constantinople).—Remittance safely received.

BOILER EXPLOSIONS FROM EXPLOSIVE GASES.

Our contemporary, the "Scientific American," remarks as follows with reference to the above subject:—From the proceedings of the Polytechnic Association it will be seen that one speaker was very desirous of an explanation, why the theory that boiler explosions are caused by an explosive mixture of gases, is not sound. This theory has been strongly urged by some pretty intelligent men, and it posseses some elements of plausibility.

It is well known that water is composed of oxygen and hydrogen; that it can be decomposed by red-hot iron—the oxygen combining with the iron, and the hydrogen being set free; and that if this free hydrogen is mixed with the proper proportion of atmospheric air and set on fire, a violent explosion takes place. It was imagined that when water gets low in a steam boiler the uncovered portions of the boiler might become red hot, and the other steps in the process might successively follow. On examination, however, this theory, like all others yet propounded, is found to be unsatisfactory.

Prof. Tillman remarked at the Polytechnic that, even if hydrogen were set free in a steam boiler, there would be no air present to mingle with it and thus to form an explosive mixture. In reply to this, the theorists would affirm that water does absorb air, and carry it into boilers, the first action of the heat being to expel this absorbed air; and the correctness of this reply must be admitted. There are, however, objections to the theory which cannot be answered.

Hydrogen and oxygen enter into chemical combination only at a high temperature. When fire is applied to a mixture of these gases, the atoms coming in contact with the fire are heated to the temperature at which combination takes place, and the heat generated in burning these raises the temperature of adjacent atoms to the point at which they combine, and thus combustion is rapidly propagated throughout the mass. If the mixture is pervaded by a sufficient proportion of steam, combustion cannot spread through the mass. It is impossible to suppose that the interior of a steam boiler is ever sufficiently free from steam to permit explosive burning of hydrogen.

If hydrogen was set free in the presence of oxygen, and at the temperature of red-hot iron, it would be burned gradually as it was liberated, instead of accumulating in quantity, and then burning explosively.

Finally, when hydrogen and oxygen are mixed in the proper proportions, and set on fire, the pressure produced is no greater than that of steam; it is, in fact, the pressure of steam. Hydrogen, in burning, combines with oxygen and forms water; which, under the action of the heat generated by the combination, exists in the form of steam.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Jordan's Patent for Composite Iron and Wood Ships.—Jordan v. Moore.—The case was for the infringement of this patent, and was tried in the Court of Common Pleas, before Mr. Justice Byles and a special jury (of *nine* by consent). The invention is one of very great importance, and consists in making a complete skeleton or frame of the ship in iron, in which the external and internal planking (the latter technically termed the "ceiling") can be effectually secured, in order to complete the perfect ship or vessel. The details of Mr. Jordan's invention, as presented in his drawings and specifications, are that he uses a keel and keelson of iron (though there may be a partial substitution of wood for the iron), from which the iron ribs rise; the keelson also rising at the stem and stern, so as to form what may be termed an inverted arch (inside the vessel), for the purpose of strengthening the structure. The ribs are connected together by means of iron bands or stringers passing *directly* in the longitudinal direction from stem to stern, the ribs having also diagonal ties of iron, and iron ties which pass from side to side of the vessel, to secure the same transversely. It was admitted by all parties that a ship constructed as described would be a strong, seaworthy vessel; but contended by the defendant that the plaintiff's patent (a prolongation) was not valid and effectual in law because he had in his specification claimed too much, or what was not new. He had stated in that document that his claim was in effect for a complete skeleton or frame of iron (*i.e.*, a complete skeleton or frame, whether its constituent details be the same as those before enumerated or otherwise), and was not limited to the particular details he had described with reference to the drawings accompanying his specification; further that he had made a distinct and separate claim for the mode of securing the butt-joints of several parts in the structure, which butt-joints consisted simply in placing over the line of junction, on the inner side, a piece of metal, with a waterproof packing piece secured to each of the two parts, joined together, and that this was a notoriously well-known method of securing butt-joints, as practised by carpenters, shipbuilders, and other mechanics. In support of the defendant's objections be also put in evidence several specifications of old patents (anterior to the year 1849, the date of the plaintiff's original patent), amongst others, one by Mr. Watts, in the year 1814, in which the ribs were connected together and to the keel by what, although not the same in *form*, was in effect identical with the plaintiff's stringers; also a patent of Mr. Ditchburn's, dated 1841, in which truss-plates, so called, were adopted, but which were substantially the same as the plaintiff's diagonal tie system. After occupying the Court nearly three days, the case was decided in favour of the plaintiff. The verdict being for 40s. damages.

Non-Liability as Contributary.—In *re* the Agriculturist Cattle Assurance Company ("Stanhope case"), it appears that, by an arrangement between certain of the shareholders and the directors of the company, the shares of those shareholders who wished to retire from the company were to be forfeited on payment by them of certain sums of money. Subsequently to this arrangement one of the shareholders, who had not come into it, made another arrangement with the directors, by which his shares were transferred to the company on payment by him of a smaller sum than he would have had to pay under the first arrangement. The transfer of his shares was duly registered, but no other notice of it was given to the shareholders. Eleven years afterwards the company was ordered to be wound-up. It was held by the Master of the Rolls that after so long a lapse of time the transaction could not be impeached.

Solicitor and Client.—In the case of Edgell *v.* Day, the defendant, a solicitor, had been employed to sell some lands, which he did, partly by private contract and partly by auction; he received a deposit on each side, and signed receipts for them "as agent for the vendor." By the conditions of sale by auction a deposit was to be paid to him "as agent for the vendor." The defendant, on being applied to by the vendor, declined to pay over the deposits to him till the sales were completed. It was held by the Court of Common Pleas that the defendant had received the deposits as the vendor's agent, and not as a stakeholder, and that, therefore, the vendor could recover interest on them from the time of demand.

Patentees' Profits.—The Lord Chancellor has decided, in the case of Mathers *v.* Green, that a joint owner in letters patent granted to himself and another, when not engaged in the manufacture of the subject of the invention, is not entitled to a share of the profits made by his co-patentee in respect of the manufacture and sale of his own goods by the use of the patent.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Valuable Discoveries of Natural Manure in North Wales.—The phosphatic deposit recently discovered at Penygarnedd, in Montgomeryshire, has been carefully examined by Dr. Voelcker, and the opinion which he has given of its value is in every way satisfactory. The accuracy of his analysis is fully confirmed by that of Dr. Percy The Penygarnedd property is only one-quarter of a mile from a proposed railway, and has the advantage of having ample water power available at all seasons. A level has been driven 50 yards into the hill, and the deposit improves in depth.

Obtaining Heat for Generating Steam.—Major-General A. Wheatley, has provisionally specified some improvements, which relate to the use of lime combined with coal, coke, or other carbonaceous substance as fuel, aided by a draught of air in the furnaces of steamboilers. When the lime has become thoroughly ignited, the further supply may be by lime alone, or heated lime may be supplied direct from a kiln to the furnace, by which economy of fuel is obtained, the lime burning without waste, and being a saleable article after the use referred to.

Utilisation of Small Coal.—The statements which have from time to time been made as to the probable duration of our coal fields causes increasing interest to attach to every fresh endeavour to render all kinds and qualities of coal marketable. The utilisation of the small is without doubt the most important, and Mr. W. Smith, of Taunton, has invented some improvements which are calculated, it is claimed, to lead to the employment of a very large quantity of small coal. The improved machinery which forms the subject of the invention comprises a cylindrical multiple mould, the mould being formed round the periphery of such cylinder or wheel, which is caused to rotate upon a shaft in the centre. Each mould is fitted with a sliding and hinged lid, which is moved, opened, and closed by self-acting guides, and when closed and acted upon by the rollers presses the materials into the mould. The materials are fed into the machine at one side, and delivered at the other when compressed. The lids are open, and kept open through about one-half of the cylinder's rotation on one side, and are gradually closed by contact with rollers converging in a curved line to the periphery of the cylinder on the other. These lids are made of flexible plates, and are fitted with flexible hinges, to allow them to take the curved form when closing. In the bottom of each mould a piston is fitted, which presses upon the solid material when compressed, and delivers the same as the cylinder rotates. These pistons work in and out by guides, so that the machine is rendered self-acting, self-feeding, and self-delivering, by the simple rotation of the mould-wheel, and simultaneous movements of the lids and pistons.

Utilisation and Collection of Metallic Fumes.—In situations where there is sufficient room for the purpose, Mr. W. T. Watts, of Birmingham, proposes to dispense with the ordinary stack or chimney, and substitute therefor a closed flue, or culvert, connected with a chamber containing a revolving fan, by means of which fan the requisite draught is produced through the furnace. The waste gases from the furnace are directed by the fan blast into a condenser, where the oxide of zinc carried from the furnace by the waste gases is condensed and collected. The said condenser consists of a chamber filled with fragments of coke, or other solid, unacted upon by water, the said fragments being kept wet by a stream of water. The waste gases are passed downwards through the condenser and the stream of water condenses and carries down the oxide of zinc. The mixture of water and metallic oxide is received in a reservoir at the bottom of the condenser, and the water is separated from the metallic oxide either by filtration or decantation. Where one fan is insufficient to produce the blast necessary for the proper working of the furnace, it may be supplemented by another fan to direct a blast from the ash-pit into the fire between the bars of the furnace. Where there is not sufficient room for the flue or culvert described, or where it is wished to apply the invention to furnaces already constructed, a downward flue may be connected with the top of the ordinary stack, and the fan blast made to conduct the waste gases from the stack through the said downward flue to the condenser.

New Steam-Boiler.—At the Novelty Works, New York, an improved steam-boiler, the invention of Mr. E. Danforth, of Geneva, Illinois, has been constructed. Within a hollow iron sphere 2½in. thick, and with a diameter of 30in. × 22in., is a common ⅝in. gas-pipe, running to within a few inches of the bottom, and terminating in a small ball or sprinkler, perforated with several diminutive holes. The fire is built under the globe, and in the sprinkler is a tablespoonful of water. The air in the sphere is at a temperature of from 500 to 600° by Fahrenheit's thermometer. The water in the sprinkler is hot, and the sprinkler soon becomes surrounded by a superheated vapour, in which the water is spurted, becoming heated steam before it can reach the surrounding sphere. This spurting or ejectment of water from the pipe is repeated as soon as a revolution of the engine attached has consumed the steam just made, and the engine itself—a 5 horse-power, with a cylinder of 5-in. bore, and a piston 8in. long—is propelled with the force of an engine of 15 horse-power with a pressure of 130lbs. An estimate, considered moderate, contemplates the saving of 40 per cent. in fuel over the ordinary mode of generating steam. Objections have been raised that the iron globe, or steam generator, cannot be durable. It is estimated, on a scientific basis, that it will last quite as long as the common boiler, and it is stated that it works well, noiselessly and rapidly, the steam generated by this method having elasticity not attained by any other process.

In Chicago a building, 80ft. by 160ft., five stories high, and weighing 27,000 tons, has recently been raised 2ft. from its original foundations. It was done by means of 1,580 screws placed underneath the building and turned simultaneously. The work occupied three days.

Gun Cotton for Blasting Purposes.—A very important trial of the efficiency of gun cotton as compared with gunpowder, for blasting purposes, took place on the 19th ult. at the Trow Rock Quarry, South Shields. The experiment was for the purpose of trying gun cotton, prepared under the process of Baron Lenk, and of which Messrs. Thomas Prentice and Co., of Stow Market, are the sole manufactures in England. The gun cotton, on this occasion, was placed in six barrels, each of which contained 120 pounds of the explosive material, and there were placed three barrels at each end of shafts driven laterally right and left in the rock, from the end of a heading which was driven right into the rock to a depth of thirty feet from the face. As each of the lateral shafts was thirty feet in length, there were thus sixty feet between the barrels of cotton. In each barrel an Abel's fusee was placed, and these were all connected with an ebonite frictional electric battery. The advantage expected to accrue from the substitution of this gun cotton for powder are the more economical working, arising from the greater power of the cotton. For example, there were in the mine to be exploded yesterday afternoon 720lbs. of cotton; while, had it been powder that was employed, there would have been twenty barrels of blasting powder, each containing 100lbs., or 2,000lbs. in all. There was a large and influential attendance of gentlemen to witness the experiment, and amongst these were most of the Tyne Commissioners. The experiments were, it it is stated, in every respect, highly successful.

Patent Metallic Glass Houses.—Mr. Beard, of Bury, according to the local *Post*, has at the Victoria Works, a large conservatory, on his patent principle, the temporary erection of which, previous to its removal to its destination in South Wales, has just been completed. The dimensions of the house in question are,—length. 35ft.; width, 16½ft.; height, 13ft. to the apex. The lines of its roof are curvilinear in form, being in segment of a polygon in a circle, surmounted by a Λ-shaped ridge, the sides of which form the upper ventilators. The lower ventilators run along the sides next the floors, both series being opened and closed by the endless screw, which forms a feature in Mr. Beard's patent top and bottom ventilation. At each of the angles of the roof the lower vertical sash-bars are made with a shoulder, against which the upper pane of glass rests. This ensures a firm and weather-tight junction of the squares, while at the same time the

evils of overlapping panes are obviated, since the upper forms an angle with the lower, which it overhangs. A process of covering the ironwork with enamel-paint, so as to reduce the cost and trouble of repainting to a minimum, completes the structure.

The American Patent Office.—During the year ending September 30, 1865, there were received at the patent office 11,860 applications for patents, and 70 applications for an extension of patents. 6,292 patents, including re-issues and designs, were issued, and 61 extensions granted. 1,530 caveats were filed. 741 applications allowed, but no patents issued thereon by reason of the non-payment of the final fee. On the first day of October, 1864, there was a balance to the fund of 56,117 dollars and 39 cents. The fees received for the succeeding twelve months amounted to 316,987 dollars and 27 cents. The expenditure during the same period were 262,445 dollars and 47 cents. Leaving a balance on the 1st day of October, 1865, of 110,659 dollars and 19 cents. The law provides that in interference cases, or where letters patent have been refused, an appeal lies from the decision of the primary examiner to the examiners-in-chief, and from their decision to the Commissioner of Patents. According to a judicial construction of existing laws, an appeal may be taken from the decision of the commissioner to the chief justice, or one of the associate judges of the Supreme Court of this district. This procedure is unnecessarily circuitous and protracted, and should be abridged by an amendment of the law so as to allow an appeal from the decision of the primary examiner or the examiners-in-chief directly to the Supreme Court of the district of Columbia, if the party against whom it is rendered so elects. The Commissioner of Patents is clothed with unrestrained discretionary power in all cases of application for the extension of patents. His decision, whether favourable or unfavourable, is final, and frequently involves private and public interests of enormous value. It is submitted for the consideration of Congress whether it is wise to lodge so large a power with a subordinate officer, without subjecting its exercise to the supervisory control of the head of the department.

Labour-saving Machinery in America.—The manufacture of newly-invented machinery, known as harvesters, mowers, reapers, and headers, gives employment to a large amount of capital and labour. The introduction of this class of machinery has brought about a revolution in labour as applied to agriculture and, and pending the war released a large proportion of the farming classes to bear arms. Last year, the number of reapers and mowers made in the United States, according to the *New York Journal*, was not far from 89,000; but of the stock of machines on hand at the opening of the present season, fully one-quarter, and perhaps one-half, remains unsold. This year, at least 100,000 machines have been made. There are two principal patents in the United States high in favour among farmers. One is the "open finger" guard, from which the patentee secures a royalty on every successful machine, say two dollars 50 cents each, or an income estimated at 200,000 dollars per annum. The other is the "hinged floating finger bar." The income from the latter is between 100,000 dollars and 200,000 dollars. There are about 225 manufacturing firms solely engaged in making agricultural machinery, and pretty evenly distributed through the country.

Boring Quicksand.—The Ryhope Coal Company, in sinking their second pit, have again succeeded in passing through the quicksand, 72ft. in thickness, underlaying the magnesian limestone in the county of Durham.

Inspiring of Air.—The following interesting results were obtained from the experiments of Dr. Edward Smith on the quantity of air inspired throughout the day and night under various influences. The total quantity of air inspired in twenty-four hours, allowance being made for intervals amounting altogether to 40 min., during which records were not taken, was 711,060 cubic inches; or an average of 29, 627 cubic inches per hour, and 493·6 per minute. The quantity was much less during the night than during the day. There was an increase as the morning advanced, and a decrease at about 8.30 p.m., but most suddenly at about 11 p.m., the average depth of respiration was 26·5 cub. in., with a minimum of 18· cub. in. in the night, and a maximum of 32·2 cub. in. at 1.30 p.m. The mean rate of the pulse was 76 per min. The amount of breathing was greater in the standing than in the sitting posture. It was increased by riding on horseback, according to the pace, also by riding in or on an omnibus. In railway travelling the increase was greater in a second than in a first-class carriage, and greatest in the third-class and on the engine. Bending forward whilst sitting lessened it. The quantity of inspired air was increased by exposure to the heat and light of the sun, and lessened in darkness. When tea was taken an increase was the result; coffee caused a decrease. Supper of bread and milk also caused a decrease, but milk by itself or with suet caused an increase. An increase was obtained with the following articles of diet, viz., eggs, beef steak, jelly, white bread, oatmeal, potatoes, sugar, tea, rum. The following caused a decrease, viz., butter, fat of beef, olive oil, cod-liver oil, arrowroot, brandy, and kirchenwasser.

Chlorine Hydrogen.—The resistance to combination of the mixture of chlorine and hydrogen, which is overcome by exposure to light, can be increased by various circumstances. The presence of a very small quantity of foreign gas in the standard mixture of chlorine and hydrogen is sufficient to cause the resistance to be increased to a very great extent. An excess of ·003 of hydrogen reduced the action from 100 to 38.

A Rod of Deal 33in. long, and weighing when dried 425 gr., gave the following results: Its expansion when dry, with 26lb. tension, was ·00000428, and with 226lb., ·00000438; but when made to absorb water its coefficient of expansion gradually decreased, until, when it weighed 874 gr., indicating an absorption of 449 gr. of water, expansion by heat ceased altogether, and on the contrary a *contraction* by heat equal to ·000000636 was experienced.

Experiments on the Stretching of Solids showed, in the case of the metals, a decrease of temperature when the stretching weight was applied, and a heating effect when the weight was removed. An iron wire of ·25 of an inch in diameter was cooled, ·125 of a degree Centigrade when stretched by weight of 775lb. In the case of india-rubber it was suggested that this substance stretched by a weight is shortened by increase of temperature. On trial it was found that india-rubber when stretched by a weight capable of doubling its length, has that length diminished by one-tenth when its temperature is raised 50° Cent.

M. Fresenius has found that 1,000,000 parts of atmospheric air contain during the day, ·098 parts of ammonia; a quantity equivalent to 0·283 parts of carbonate of ammonia; and, during the night, 0·169 parts of ammonia, equivalent to 0·474 parts of of the carbonate. Much importance it attached to the presence of ammoniacal vapour in the air, as the source of nitrogen in vegetables.

The Total Number of Visitors to the Exhibition of 1862, excluding the staff and exhibitors' attendants, was 6,117,450, or 87,000 over that of 1851. The Exhibition of 1862 was open for seventeen days longer than that of 1851. The estimated value of the articles exhibited in 1851, excluding the Koh-i-noor diamond, was £1,781,929 11s. 4d., of which the United Kingdom is represented by £1,031,607 4s. 9d.

The Experimental Boiler made in the factory at Woolwich Dockyard, and which has been at work at intervals during the past 15 months, in testing petroleum, shale, and other oils, for steam purposes, to supersede the use of coals, has been given over to the Admiralty authorities by Mr. Richardson on the completion of his experiments, which it is stated have thoroughly matured the principle, and rendered his theory a matter beyond doubt. Mr. Richardson has likewise, at their Lordships' request, submitted plans for the conversion of the ordinary ships' boilers into boilers for which petroleum can be used. This, it appears, can be done at small cost.

NAVAL ENGINEERING.

Trial of a Twin Screw Armour-Clad Vessel.—The application of twin screws to armour-clad vessels, in combination with the turret system, for carrying heavy guns on a light draught of water, has been successfully carried out by Messrs. Laird Brothers in a vessel recently completed by them. She is of the following dimensions:—Length, 180ft.; with, 35ft.; tonnage, 1,000; draft of water, 8ft.; power of each pair of engines, 70-horse power, or 140-horse-power collective. The hull is strongly built of iron, and subdivided by bulkheads into several water-tight compartments, enclosing machinery, turret-space, magazines, and accommodation for officers and men, means of communication being provided by water-tight doors in the several bulkheads. The armour-plating is 4½in. thick, and extends from the deck to three feet below the water-line, protecting turret and machinery, tapering at the extreme ends. The turret is fitted on Captain Cowper Coles' system, and carries two 150-pounder guns, and is protected with armour-plates 4½in. thick, secured on to teak backing 16in. thick. The trials were made with the vessel completed in every way, and having all her weights on board with the exception of guns, ammunition, and sea stores. The speed of the ship was tested by six runs at the measured mile, giving a mean speed of 10·5 knots; the engines averaging 112 to 114 revolutions. The supply of steam was plentiful at a pressure of 22lbs. per square inch. The engines worked smoothly, and without any heating of the bearings. After the trials of speed, the turning powers of the vesse were tried, under various conditions, with very satisfactory results, fully bearing out the anticipations that have been formed as to the advantage to be derived from twin-screws in manœuvring vessels in narrow channels or harbours; as by using the engines for turning, independently of the rudder—one screw being driven ahead, and the other astern—the vessel was circled round on her centre, and could thus be placed in any position that might be desired for bringing her guns to bear without necessarily making any progress through the water to give steerage way. An experiment was also made in steering the vessel when at full speed, by increasing and diminishing the speed of the engines alternately, without the use of the rudder, to show how far dependence might be placed on this system in the event of the steering gear being damaged by shot, or the rudder injured by striking on a bar or rocky bottom, and it was found that the vessel was quite under command in steaming up against the strong tideway of the Mersey.

The Barracouta, 6, paddle-wheel sloop, 1,053 tons, 300-horse power, which has been thoroughly refitted in machinery and hull and brought forward for the first division of the Sheerness Steam Reserve, was taken on trial to the Maplin Sands on the 14th ult., for the trial of her machinery. The vessel gave an average speed of 10½ knots per hour. The machinery worked well, and the trial gave entire satisfaction.

The "Amazon."—A contractor's trial of the engines of the screw steam sloop *Amazon*, 4, took place outside Plymouth Breakwater on the 1st ult., when the weather was extremely calm. The *Amazon* is from lines by Mr. E. J. Reed, Chief Constructor of the Navy. She is a wooden ship of 1,081 tons, built at Pembroke, with a wooden prow, iron deck beams, and iron masts. Her length is 187ft., her breath 32ft., and her present draught 13ft. 6¼in. forward; and 16ft. 5¼in. aft. The sloop is intended for a first-class despatch gun vessel; she is full rigged, but is not yet supplied with armament or stores. The fuel on board was about 200 tons. Her engines, of 300 horse-power nominal are direct acting horizontal, with surface condensers, superheaters, &c., by Messrs. Ravenhill and Co. Six runs at the measured mile under full-boiler power produced a mean speed of 12·053 knots, and two runs at half-boiler power of 10·319 knots. The load on the safety-valve was 27lb.; pressure of steam on boilers, 25lb.; vacuum in condensers—full power forward, 27; aft, 27; mean pressure on cylinders, 26·75lb.; weather barometer, 30 deg. 10 sec. The propeller was four-bladed, diameter 15ft., pitch 12ft. 6in. The boilers produce abundance of steam, and the engines worked most satisfactorily.

Naval Appointments.—The following naval appointments have taken place since our last. G. Fordham, first-class assist. engineer, to the Tamar; J. Melrose, first-class assist.-engineer, to the Gleaner; M. J. Shannon, first-class assist.-engineer, to the Triton; W. J. Hancock, first-class assist.-engineer. to the Fisgard, for service in the Prince Albert; R. J. Butler, second-class assist.-engineer, to the Oberon; H. M. G. Pellew, acting second-class assist.-engineer, to the Cumberland, for service in the Wildfire.

STEAM SHIPPING.

Shipbuilding on the Mersey.—The *Liverpool Albion* gives some interesting particulars showing that the whole number of vessels of every character built and launched at the various building yards on both sides of the Mersey during the past year amount to seventy-three, representing an aggregate of 50,414 tons. Of this number fifty were built at the several yards on the Liverpool side of the river, their united tonnage being 28,970 tons, of which Messrs. Jones and Quiggin built fifteen vessels, representing 9,863 tons. Both as regards the number of ships built, and the tonnage they represent, Messrs. Vernon are next in rotation, they having launched seven vessels, whose aggregate was 5,523 tons; whilst Messrs. Roydeu furnished five vessels, representing 5,670 tons. On the Cheshire shore the number of vessels launched was twenty-three, with an aggregate of 21,514 tons, towards which the extensive works of Messrs. Laird Brothers contributed more than one-half of the whole, both as regards the number of vessels built by the firm and the tonnage they represent, independently of the Agincourt. The number of vessels built and launched by this firm during the year is twelve, their aggregate amounting to 13,157 tons. All the vessels named have been constructed of iron and steel, with the few exceptions we have named, and which refer to the composite ships. The steel-built ships are in the main those which have been constructed by Messrs. Jones and Quiggin, the rest of the builders confining themselves chiefly to iron. Of the entire number of seventy-three vessels launched during the year in the port, thirty-five were sailing vessels, nineteen paddle steamers, and nineteen screw steamers. The several builders on both sides of the river appear at the present time to have a considerable number of orders on hand, and on the Liverpool side of the river alone, six vessels of large tonnage, which are now nearly completed, will be launched within a fortnight, whilst within the same period there will also be several ships sent off the stocks on the Cheshire shore of the Mersey.

LAUNCHES.

Launch of a Steam Barge.—Messrs. J. Wigham Richardson and Co. launched, on the 18th inst., from their ship-building yard, at Low Walker, an iron screw hopper ballast barge, the property of the River Tyne Commissioners. Her dimensions are:—Length, 111 feet; breadth, 28½ feet; depth, 14 feat. She will be propelled by a pair of engines, with 20-inch cylinders, 24-inch stroke, supplied by steam from two cylindrical boilers. An hydraulic crane will also be fitted in the fore part of the vessel, for the purpose of discharging ballast from vessels into the well of the hopper, from which it will be unshipped at sea. The machinery and crane are from the workshops of Sir Wm. G. Armstrong and Co., of Elswick. The vessel and machinery are from the designs of John F. Ure, Esq., of Newcastle, under whose superintendence she has been built.

The "Fairy Vision."—Mr. J. G. Lawrie, Whiteinch, launched, on the 3rd ult., a screw steamer of handsome model of the following dimensions and tonnage:—Length, 197ft.; breadth, 24ft. 7½in.; depth, 15ft.; 600 tons. The vessel is to be immediately placed on the London and Mediterranean station, being commodiously and comfortably fitted for passengers, as well as being adapted for cargo.

Launch of the "Ville de Paris."—There was launched, on the 22nd ult., from the building-yard of Messrs. R. Napier and Sons, Govan, a large screw-steamer named the *Ville de Paris*, and sister ship to the *Pereire*, both vessels being constructed for the Compagnie Generale Transatlantique of France, and intended for the mail service between Havre and New York. The dimensions of these vessels are:—Length, about 350ft.; breadth, 44ft.; depth, 29ft.; builders' tonnage, 3,300 tons; horse-power, 800. The launch of the *Ville de Paris* was most successful; and the ceremony of naming the ship was gracefully performed by the lady of the Hon. the Lord Provost.

Launch of the "Malaga."—This ship was launched, on the 1st ult., from the ship-building yard of Messrs. J. and R. Swan, Kelvindock; she is an iron screw steamer of 400 tons burthen. This is an addition to the fleet of steamers already built by Messrs. Swan for Messrs. Mories, Munro and Co., of Glasgow, chiefly for their trade with Spain.

Launch of the "Rohilla."—Messrs. A. Stephens and Sons launched from their building yard at Kelvinhaugh a fine composite sailing ship, for Messrs. Finlay, Campbell, and Co.'s Bombay line. The ship is named the *Rohilla*, is 1,050 tons, 15 A 1 at Lloyd's, and is sister ship to the *Mofussilite*, built by Messrs. Stephens for the same eminent firm. The berth just vacated by the *Rohilla* is to be immediately occupied by a large screw steamship for Messrs. Handyside and Henderson's New York line.

TELEGRAPHIC ENGINEERING.

Continental Telegraphic Convention.—An imperial decree has just been published in Paris promulgating a convention, concluded in May last, between France on the one part, and Belgium, Austria, Baden, Denmark, Spain, Greece, the city of Hamburgh, Italy, Holland, Portugal, Prussia, Russia, Saxony, Sweden and Norway, Switzerland, Turkey, and Wurtemburg on the other, and which has for its object the organisation of the entire telegraph system, and the establishment of a fixed international tariff. The despatches are classed under three heads—those of the State, or Governmental despatches, those connected with the public service, and, lastly, private telegrams. The tariffs will affix the amounts to be received by each country as regards transmission, receipt, and transit. The ratifications have been exchanged between all the powers, with the exception of Greece, Portugal, and Turkey, in which there has been some delay, and the convention is to come into operation on the first day of the coming year. This arrangement will be of essential service to the commercial world by doing away with inconsistencies, and setting up a regular and fixed scale of charge.

RAILWAYS.

Locomotives on Railways.—The number of locomotives at work on the twelve principal railways of Great Britain at the close of 1864 was—Caledonian, 262; Great Eastern, 376; Great Northern, 345; Great Western, 697; Lancashire and Yorkshire, 398; London and North-Western, 1,187; London and South-Western, 207; London, Brighton, and South Coast, 203; Manchester, Sheffield, and Lincolnshire, 179; Midland, 512; North-Eastern, 663; and South-Eastern, 214.

New Railway Station at York.—The station at York is condemned. The directors of the line have come to the conclusion that the entire plan of the structure is radically wrong, and that the proper form of station for their purpose is not the *cul de sac* standing east and west, but a structure built on the line of the direct route outside the city walls. The new edifice is, with its belongings, to cost £200,000: its platform is to be 1,200ft. in length.

Proposed Pneumatic Railway under the Mersey.—It has been resolved to form a pneumatic railway 25ft. below the bed of the river Meresey, between Liverpool and Birkenhead. Sir Charles Fox recently gave an explanation of the project to a numerous and influential meeting at Liverpool.

Railways in Queensland.—On the 27th of September last Sir George F. Bowen, G.C.M.G., &c., Governor of Queensland, accompanied by the Minister for Lands and Works, the Colonial Treasurer, and many others, went to Rockhampton in order to inaugurate the Great Northern Railway of Queensland. Before turnning the first sod, the Governor said, in answer to an address presented by the Mayor and Corporation of Rockhampton, that when he first saw Rockhampton, in 1860, it was a small hamlet of wooden huts, with scarcely 500 inhabitants, who had recently settled down in the primeval wilderness. He recollected well that what Lord Macaulay has termed "a rude kind of patriarchal justice, which was, however, better than no justice at all," was then administered in a canvas tent whenever a magistrate happened to attend. On his second visit, in 1862, the population had trebled, and the hamlet had grown up into a thriving township, with about 1,500 inhabitants. On that, his third visit, he learned with much pleasure that their population had been again trebled during the brief interval that had elapsed since his second visit. He saw around him a flourishing town of nearly 5,000 inhabitants, with public buildings of every kind—churches, schools, a mechanics' institute, a post-office, a telegraph-office, and numerous banks and warehouses. He found a Judge of the Supreme Court, surrounded by the leading members of the colonial bar, holding the assizes for Northern Queensland in a commodious and spacious court-house. He was welcomed by a mayor and aldermen, and he remarked with great satisfaction in the wharves which lined their noble river (the Fitzroy), in the well-ordered streets of their town, and in the other signs of material prosperity, the rapid progress of those advantages which municipal self-government, when prudently and vigorously administered, was certain to confer. He entirely agreed with them in attaching high importance to the great public work which was to be initiated that day. It was acknowledged in every quarter that the most pressing need of the entire colony was the improvement of their internal communications. With this object the colonial Parliament had decided that two trunk lines of railway should be carried into the interior—one for the southern districts, from the head of the navigation of Moreton-bay (Brisbane), and one for the northern districts, from the head of the navigation of Keppel-bay (Rockhampton). It was well known that in 1862, in consequence of his urgent representations, the Imperial Government anexed to their northern territory an additional area larger than the United Kingdom, and that during several years he had spared no pains to push on two enterprises calculated to be of great advantage to the interests of the north: he meant the establishment of steam communication through Torres Straits, and the extension of the electric telegraph from Rockhampton to their north-western frontier, where it will meet the international line, which will ultimately connect Australia with Asia and Europe. Both these projects had received the sanction of the colonial Legislature in its last Session, and both would be carried into execution forthwith by his constitutional Ministers. The report of Mr. H. T. Plews, chief engineer, states that the Great Northern Railway will run from Rockhampton nearly due west with the interior, passing through Westwood and other townships, and traversing the extensive Leichhardt, and will eventually reach Clermont—a township on the Peak Downs, distant about 220 miles from Rockhampton; thus opening up a vast territory, and enabling squatters to convey their wool speedily and cheaply to the port of Rockhampton. The *Empress of the Seas* with 550 immigrants and a large quantity of railway plant, and about 50 navvies for the Great Northern Railway works, had just arrived in Keppel-bay—the port of Rockhampton. She is one of the celebrated Black Ball line of clippers, belonging to Messrs. T. M. Mackay and Co., and was consigned to Messrs. Morgan and Allen, of Rockhampton.

Lighting Railway Trains.—An experiment for improving the method of lighting railway trains is being tried in a composite carriage on the London and North-Western Railway. It is patented by Mr. Thomas Clayton, of Manchester, and is being put into practical operation by Messrs. J. Metcalf and Sons, Miles Platting. Each carriage carries its own apparatus, which is easily arranged under one of the seats, and there is therefore no necessity for tubes running the whole length of the train. The latter system renders coupling and uncoupling a different process, which is avoided by Mr. Clayton's plan, although in his case the providing of a separate apparatus for each carriage is an important, though not expensive, set-off. It is three or four years since the system was first tried, and it has been experimented with on the London and North-Western Railway for nearly six months. The gas is not produced from coal, but is hydrocarbon, or simply carbonised atmospheric air. It gives a remarkably brilliant light, as strong and as full as need be wished for, and it is free from impurities. The apparatus for producing it is strong and simple. It consists of three parts—a generator, a regulator, and the motive power. The generator is a tin box, divided into cells filled with sponges, and the latter are saturated with a light petroleum spirit. By driving a current of atmospheric air over this spirit it becomes carbonised, and passing from the generator to the burners in the several compartments, it becomes ready for use. The regulator is a small instrument adapted to keep the current of air at an equal pressure, and the motive power is used to force the air through the regulator to the generator. This is done, first of all by a spring and chain made and wound up on the principle of a watch. The tension of the spring and chain turns a drum, which revolves in water, and which drum is divided into cells. As each cell rises above the water within the drum it is filled with air, and in the course of its revolution the cell discharges its contents into a chamber that communicates with the regulator. To prevent freezing, which always arises from rapid evaporation, some of the cells of the generator are filled with sawdust. The pressure of the exterior air on the burning lights is regulated by a simple apparatus, which need not be described. When the train is at a standstill, the light is not quite so brilliant as when it is in motion, and when passing through tunnels the impure compressed air and steam somewhat affect the steadiness of the light; but even in the long Standege tunnel this unsteadiness is much less than the unsteadiness of any other light. One gallon of petroleum spirit, costing about 3s. 6d., will produce 800ft. of gas, so that the expense is very much less than the lighting of a train with coal gas, and a fortnight's supply of spirit occupies very little room. The winding up of the motive power must be done about once in sixteen hours.

RAILWAY ACCIDENTS.

A Collision took place on the London and North-Wertern Railway on the 27th ult. The morning express down train was brought to a stand still near Wolverton, in consequence of some defect in the engine. The passengers, however, kept their seats, and while the driver and the guards were endeavouring to repair the defects, an engine and tender ran into the stationary trsin, the fog being at the time very dense. Several of the passengers were a good deal shaken.

BOILER EXPLOSIONS.

Locomotive Boiler Explosion. — another locomotive boiler recently gave way at the fire-box. This time the explosion took place on the Blyth and Tyne Railway, near Newcastle. Both the fireman and engineman were killed by scalds caused by the escaping water and steam. The fire-box gave way at the left side, the plate on the left side being entirely blown away, with a portion of the front and back plates and a little of the crown. The jury returned the verdict "that the explosion took place in consequence of the defective state of the stays of the fire-box, and the pressure of steam that was upon it." This verdict was justified.

DOCKS, HARBOURS, BRIDGES.

Chisenhale Bridge, Liverpool.—The foundation-stone of the new bridge across the canal at Chisenhale-street, in Vauxhall Ward, Liverpool, has been laid. This new bridge, will be built of parbold stone and cast iron girders, and will have a roadway of 28ft., considerably more than double that of the old one, and the incline from the middle towards each end will be so easy as to be scarcely perceivable. It will be a single arch, with a span of 39ft., and the cost under contract will be close on £4,000, but, including the land approaches, it will amount to £4,500.

MINES, METALLURGY, &c.

Atmospheric Ore Stamp.—An improved machine has been invented by Mr. Hughes, of New York, for the reduction of gold and silver ores to an impalpable powder, very simple in its construction, little liable to get out of repair, and easily repaired by an ordinary mechanic when necessary. The stamp used is but 75lbs. weight, yet by atmospheric pressure the inventor claims that it strikes a 4,000lb. blow, with the average rapidity of 200 blows per minute, of 400 with the two that are used in the machine. The piston (and stamp-head) is raised by a double cam on the main shaft, alternating the blows, which the pateutee considers equivalent to a balance-wheel. It is thus raised, with a valve on the top of it, into an atmospheric chamber, thereby creating a vacuum under the valve, which gives such great momentum to the stamp when relieved from the upward motion of the cams as to produce the results above mentioned. The principle upon which it is constructed can be seen at a glance. The same principle can be applied as easily to any number of stamps as to two, and with equal facility it can be applied to the stamp-mills now in general use. Most practical millmen are firm in the conviction that the stamp system of reduction can never be bettered, and therefore never superseded. But, as at present constructed, they are large, costly, cumbersome, and difficult of transportation. The mill being small, compact, and portable, will prove of immense value to mines situated far from the seaboard.

Ancient Mining.—Interesting Discovery.—Miners who work in the Spanish silver mine, known as the "White Pebble Pit," belonging for a long time to the Orfila family, have just made a discovery, which is alike interesting to art and archæology. Whilst digging their subterranean walks, they suddenly found themselves in passages, whose origin dates from the remotest centuries. They further discovered a thorough and scientific system of mining, the implements being in such a good state of preservation that it could be determined that it was not a Roman, but a Carthaginian or Phœnician mine. The hatchets, sieves for ore, but particularly a smelting-furnace and two anvils, excite the interests of engineers in the highest degree. All these articles were carefully collected, and will enable scientific examinations to be prosecuted with greater exactitude than was possible after a merely superficial view. Particular attention will be paid to the remarkable instruments and objects of art which are said to fill the niches of a rotunda in the centre of the mine. This rotunda appears to have been the spot dedicated to the gods presiding over mines. It was occupied by three statues: one sitting down, and of half life-size, and the other two standing, and about 3ft. in height. These statues remind us neither of Roman nor Grecian art, but rather touch the style of that work of sculpture which was discovered in the year 1854 on the other side of the mountains, and which is now being preserved in the America, at Madrid, and is known as the "Carthaginian Hercules." The same symbols are found on a tripod, and on a chest, which were leaning against the sides of the rotunda. Men of science were already excited by the discovery of 1854; the present one will certainly throw a new light on the study of a civilization once very mighty, but now almost extinct. The tools, implements, and objects of art at present from part of the cabinet of M. Lassary, of Valltdolid.

The New Blasting Powder.—A comparative trial, extending over upwards of a month, has heen made at the Roundwood Tunnel, near Duhlin, for the purpose of ascertaining the practical value of Messrs. Schaffer and Budenherg's new hlasting powder. With the new powder, the progress made with a driving in No. 1. heading 6ft. x 5ft., was 7ft. in 168 hours, whilst with the old powder it required 200 hours to drive 4ft. 6in. In No. 2 heading, dimensions as before, with the new powder, 5ft was driven in 168 hours, whilst with the old powder ouly 4ft. were driven in 200 hours. It will thus he seen that 41 per cent. more work was done in 16 per cent. less time.

Copper Mines in New South Wales.—At the present time a perfect *furore* for copper mining prevails in the western districts, and rich veins of copper have heen traced from the Canohias mountain range, that divides the Lachan watershed from that of Macquarie, to Carcoor on the south, and to Ophir on the north, or over an extent of country fifty miles in length. The principal copper mine as yet at work is that of Cadiangulong, on the southern watershed of the Canobias, and ahout sixteen miles from Orange. It employs when in full work 250 hands. The smelting-works at Cadlangulong are very complete, and work ahout 200 tons of ore per month, returning on an average ahout 30 tous of pure copper. The Carangara Copper Miue is ahout eighteen miles distaut from Cadiangulong, in a northerly direction. The mines have been opened for some years, and smelting works were erected on them. But the mistake was made of putting up blast-furnaces, and the company found they could not get a sufficient percentage of copper to pay. The ores are gossan to the 10fm. level, when the sulphurets commence. In the Southern district a copper mine has heen opened at Curawoug, twenty-two miles south from Goulhurn, and ahout seven north of Collecter. It is yet only in its infancy, hut a valuahle vein of black ore has heen struck at a depth of 7fm. There are also numerous veins of gossan ores traccahle ou the surface.

ACCIDENTS TO MINES, MACHINERY, &c.

Fatal Explosion at Clifford Amalgamated Mines.—Ou the 12th ult. an accident happened in the Clifford Amalgamated Mine to two men, father and son. The two men were engaged in driving the 220 fathom level, west of Taylor's shaft, when the hole they were tamping, prematnre exploded, killed the father, and iujuring the son so badly that hut slight hopes are entertained of his recovery. No douht had the ramming or tamping-bar heen formed of copper in lien of steel this accident, and many others of a similar natnre, might have heen averted.

Coal-Pit Explosion at Merthyr.—An accident occurred at Merthyr Tydvil on the 20th nlt., in the Upper Gethin Coal-pit, belonging to Mr. William Crawsbay, of Caversham-park, Reading, and proprietor of the Cyfarthfa Ironworks. It will he in the recollection of many readers that about four years ago a similar catrastrophe, happened in this place, by which 47 men and boys were killed. The scene of that calamity was also the Gethin pit; but, in order to make it clear to those unacquainted with the place, it will he necessary to state that the Gethin pit comprises two systems of coal workings connected hy two drifts or headings, and to a certain extent they have one system of ventilation common to hoth. They are situated one ahove the other on the side of the mountain, the shafts heing about 603 yards apart, and thus go hy the names Upper and Lower Gethiu, being worked as two distinct pits. In the lower pit, which was the scene of the former accident, two seams of coal are worked respectively 4 feet or 3 feet in thiekness, while in the Upper Gethin, which is ahout 200 yards deep, 70 yards deeper than the Lower Gethin, the 9 feet coal is worked. The Upper Gethin, the scene of the present disaster, is a much newer pit than the Lower Gethin—in fact, it was sunk for the purpose of securing a more eminent and perfect ventilation for the Lower Gethin—and the workings have not heen very far extended yet. There is only one up-east for the two pits. The explosion took place in a heading on the east level, in which there were ahout 40 meu at the time, and out of that numher no less than 30 have been killed. All the rest, with two exceptions, are hurned and buised frightfully, and the force of the hlast was so great that it extended to the whole level and injured many other men, so that uo fewer than 22 were more or less seriously injured. The accident happened ahout 8 o'clock, about an hour after the "day turn" hands had gone in. Nohody knows where it broke out, hut an old stall is mentioned hy several colliers as having heen reported ou fire," and it is said that the overman had warned the colliers against entering it in consequence; but nothing positive can be said on this head. Out of the 30 men and hoys killed only three met their death by the fire, hut these were scorched almost to a cinder and their features were so ohliterated that they could hardly he recognised.

GAS SUPPLY.

The Right of a Gas Company to Cut Off the Supply of Gas.—A case has heen argued in the Bacup County Court, in which an auctioneer sought to recover £2 as damages from the Rossendale Gas Company, on account of their having, as alleged illegally, cut off his supply of gas. The company had claimed from the plaiutiff 7s. 6d for gas consumed hy a former tenant, who happened to be his brother. The plaintiff declined to pay the bill, alleging that he was not liahle, and the defendants ceased to supply him with gas. His Honour gave judgment for the plaintiff for 10s. aud costs.

The Oriental Gas Company have held a meeting at which, out of an available balance of £6,596, a dividend at the rate of 8 per cent., free of income-tax, was declared.

WATER SUPPLY.

The Proposed New Water Works at Greenock.—The following sketch of the proposed new water works we quote from the *Greenock Advitiser*:—"Last year the authorities, alive to the great deficiency, and warned by the injury done to the health of the population hy the defect, applied to Parliament for power to obtain an adequate supply of good quality for the domestic, sanitary and mill requirements of the town, hy impounding the waters of the upper drainage area of the Gryfe, and they also included in the scheme a portion of the Blacketty, Burnhank, and Green Water streams. The works to accomplish the end in view were an embankment, 83ft. in height, across the valley of the Gryfe, having slopes of 3½ft. and 2½ft.. The site for the embankment was close to and on the east side of Garshangan Burn on the properties of Sir Michael Robert Shaw Stewart, Bart., and Mr. M. Hill, of Greenock. The works were opposed in Parliament, and the scheme was defeated on standing orders. The Provost and Magistrates immediately ordered a thorough examination of the hills to the south of Greenock, hetween Kilmalcolm on the east and Kelly on the west, and as far south as the water-shed leading down to Lochwinuoch. This survey produced a report from Messrs. Forman and M'Call, C.E.'s, Glasgow, showing three distinct schemes for introducing water to the town. Each of the plans were carefully considered by the Water Trust, and they were submitted to Sir Michael. The investigation has resulted in the adoption of the Gryfe scheme as the hest for the supply of the town. The scheme which now goes before Parliament is different from that of last year, in having two reservoirs instead of one. The embankments are to suit 47ft. height of water, with slopes 3½ft. and 2½ft. to one, and giving large accommodations for waste water—all to he formed out of the solid strata. The site of dam No. 1 is a little farther to the west then formerly proposed, so as to exclude Garshangan Burn, and Blacketty, Burnhank, and Green Waters from the scheme, as well as the supply to mills. But the Wee Burn rising in the lands of Darndaff, Burnbrae, and Glenhrae, on the eftate of Sir Michael, is to he diverted into the dam No. 1. In leading water into Greenock, the connection between the Gryfe and the east side of Whinhill dam is formed hy a tunnel, 2,500 yards in length, under the hill, and the water is conveyed into that reservoir by an open aqueduct, sent into a series of filters, thence distributing hasin upwards of 450ft. above the level of the quays, and carried into the town hy a large cast iron pipe laid across the eastern end of the Whinhill, through Wellington Park, Baker-street, Dellingburn-square, and Dellinghurn-street, reaching Rue-end-street, from which point the network of water pipes will he laid down. In order to accommodate the land and mill owners on the River Gryfe, a large reservoir called No. 2 crosses the valley in a line with the farm-steading of Mansfield, and is on the properties of Sir M. R. Shaw Stewart and Mr Scott of Kelley. This dam is to he specially constructed to give off to the landowners and millowners on the Gryfe compensation water equal to the drainage area impounded. The sites for the embaukments for hoth reservoirs are of the very best strata suitable for such a purpose, and there is a sufficiency of good clay aud other materials iu the locality with which to construct the works of the strength required hy the engineers."

APPLIED CHEMISTRY.

A Lecture Experiment. By K. Kraut.—Take a platinum wire 0·5mm. thick, aud wind it fifteen or twenty times around a lead pencil, so as to form a spiral; when made, pass one end of the wire through a cork, and let the spiral hang into a wide-necked flask standing on wire gauze over a lamp. The cork must he loosely laid lengthwise over the mouth of the flask. Pour into the flask so much liquor ammonia (20 per cent.) as almost to reach the end of the spiral. Carry a glass tuhe. ahout 10mm. wide, from a gasometer full of oxygen, into the flask, so that the end ef the tuhe may dip a little under the ammonia. Now make the platinum spiral red hot, and allow the oxygen to enter. The platiuum soon becomes heated to a hright read heat, and the flask is filled first with white vapours of nitrate of ammonia, and then with deep red vapour of nitrous acid; the glass tubes which carries the oxygeu hecomes coated with a thick crust of nitrate of ammonia. If now the lamp under the flask he lighted and the ammonia heated, the mixture of ammoniacal gas and oxygeu explodes with a quite harmless explosion. By this the platinum spiral is cooled below the temperatnre of a red heat; hut after a few moments it again hecomes a bright red, aud the gaseous mixture is exploded as before, so that the experiment goes on repeating itself as long as desired. On introducing a very rapid stream of oxygen the gas burns for some time nnder the liquid. It continues to hurn, producing the long-drawn sound of the chemical harmonica if the opening of the tube he held immediately ahove the level of the ammonia and quite close to the platinum spiral. The oxygen ammonia flame then appears as a greenish yellow buhhle at the mouth of the tube, which may he moved up aud down without exinguishiug the flame.

Soda from Cryolite.—The Pennsylvania Salt and Alkali Manufacturing Company, U.S., are at present trying a process of obtaining soda, which consists in mixing cryolite with lime and heating it. The fluorine leaves the cryolite and comhines with the calcium of the lime, forming fluoride of calcium, while the two metals remaining ahsorh oxygen, hecoming alumina and soda—a soluble compound. This is treated with carbonic acid which combines with the soda, forming carbonate of soda; this remains in solution, while the alumina, being insoluble, is precipitated. Carbonate of soda once obtained is treated in the usual way.

Preparation of Iodine of Potassium.—Fuchs places 100 parts of iodine in a porcelain dish with 260 parts of distilled water, aud adds thereto 75 parts of pure carbonate of potash and 30 parts of iron filings. The mixture is well stirred together, and allowed to stand. The action proceeds slowly by itself, but is hastened by the application of heat. When the evolution of carhonic acid has ceased, the mixture is evaporated to dryness with continual stirring. It is hetter to allow the mixture to stand for some time in a lukewarm drying oven until all the iron is peroxidised; and then evaporate to dryness. The dried mass is then dlaced in an iron vessel and heated to a dull redness. The residue is then extracted with the smallest quantity of distilled water; the solution, which has usually an alkaline reaction, is then saturated with hydriodic acid, and set aside to crystallise.

Note on the Preparation of Alizarine. by J. Wallace Young.—Having been lately engaged making some alizarine, and after having tried various methods, I find that on a small scale the following process gives good results, and is readily performed. Garanoine of good quality is extracted with alcohol; the solution is distilled to recover excess of alcohol, and the residuum is carefully dried. A little of the extract so prepared is placed in a small porcelain hasin, and over it is inverted a small heaker glass over the mouth of which a piece of filtering-paper has been tied. A very gentle heat is now applied to the basin, the extract soon fuses, and alizarine sublimes, and is condensed on the hibulous paper. The success of the process depends almost entirely on the proper application and regulation of the heat; for, if it he too great, the suhlimation is conducted too hastily, and the product will invariahly he contaminated or spoiled by an empyreumatic oil which is formed. But if the temperature has heen properly regulated the alizarine will be found in magnificent orange red needles, often half an inch in length, adhering to the filtering-paper. If the heat has been very low, the crystals are often found resting immediately on the surface of the extract.

On the Action of Light upon Sulphide of Lead, and its bearing upon the Preservation of Paintings in Picture Galleries.—The author's attention was directed to this subject hy observing that in the cases in the South Kensington Museum, which are painted with white lead, that substances which emitted sulphurous vapours did not cause a darkening of the surface of the case, excepting where it was protected from the direct influence of light. A number of experiments were then tried as to the action of light upon sulphide of lead produced by the action of sulphurretted hydrogen upon lead paint. A board painted white with white lead was exposed for several hours to the action of sulphuretted hydrogen, until the surface had acquired a uniform brown colour. Plates of glass of different colours were then placed upon the painted surface, one portion being at the same time covered with an opaque medium, and another left entirely exposed. The hoard was then placed facing the light. The glasses employed were red, blue, yellow (silver), violet, and smoke-colour glass. The results exhibited were after an exposure of eight days, and showed that the parts of the hoard directly exposed to light were hleached; those protected hy an opaque medium were not acted upon: while with the glasses of different colours intermediate effects were produced, those of the violet glass being most decided. Drying oils in conjunction with light rapidly hleach sulphide of lead, and boiled oil effects the bleaching still more rapidly. When water colour is used hleaching takes place, but much more slowly than iu the case of oil. After quoting authorities, stating that generally light was advantageous to the preservation of pictures, Dr. Price showed a striking illustration of this fact. He had a picture painted, and then exposed it to the action of sulphurretted hydrogen, until it hecame sadly discoloured, and to all appearance destroyed. Some strips of paper were laid across the picture, so as to cover some parts. The picture, thus partially covered, was exposed to light for a long time. The result, as shown at the meeting, was very curious indeed, the parts of the picture exposed heing perfectly restored, while those protected by the paper remained still discoloured. From his experiments he came to the conclusion that it was advantageous to have picture galleries well lighted, especially where, as in towns, the atmosphere was charged with sulphur compounds, and that it was quite a mistake to have curtains placed in front of pictures, with a view to their protection. In the course of his communication Dr. Price referred to the zinc paint for houses, and considered it likely to he acted upon, as the paint was rendered soluble by the acids contained in the atmosphere of towns.

LIST OF APPLICATIONS FOR LETTERS PATENT.

"We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated November 25th, 1865.

3027 J. Arrowsmith—Shaping and forging iron
3028 R. T. Hothersall, S. Cook, and W. H. Hacking—Healds for looms for weaving
3029 J. F. Bennett—Raising heat by the combustion of fuels of various kinds
3030 F. Trachsel and W. Hall—Moulding for casting steel, iron, and other metals
3031 J. Ferrier—Hulls and tackle of navigable vessels
3032 C. F. Whitworth—Apparatus for signalling on Railways
3033 J. H. Johnson—Cork cutting machines
3034 G. T. Bousfield—Making wrought iron
3035 T. Berrens—System of pavement

Dated November 27th, 1865.

3036 J. P. Baragwanath—Tube cutter and pipe wrench
3037 W. E. Gedge—Steam wheel
3038 W. Hodgson—Screw gill boxes
3039 J. Manifold—Construction of ships' parrels
3040 W. E. Newton—Machinery for cutting mouldings in wood
3041 W. E. Newton—Manufacture of paper
2042 W. R. Lake—Composition for enamel, paint, varnish, cement, or plaster
3043 W. R. Lake—Preserving fruit and other perishable substances
3044 W. R. Lake—Shaft shackles

Dated November 28th, 1865.

3045 F. Mols—Nautical safety apparatus
3046 R. M. Roberts—Deriving motive power
3047 C. H. Newman—Unfermented and intoxicating malt liquor
3048 W. E. Gedge—Arrangement of ovens
3049 E. Drucker—Manufacture of stays
3050 L. D. Carbonnier—Apparatus for preventing draughts of air
3051 W. Simons and A. Brown—Preventing the escape of heat from steam cylinders
3952 H. E. Newton—Chimney cowl
3053 A. V. Newton—Printing surfaces by photography
3054 A. V. Newton—Improved fertiliser

Dated November 29th, 1865.

3055 J. Thompson—Handles of tea and coffee pots
3056 H. A. Bonneville—Coverings for the head
3057 T. Laurie—School desk seat and table
3058 P. Gaskell—Communicating rotary motion
3059 H. A. Dufrene—Stretching and rolling fabrics for dyeing
3060 J. Stokes—Manufacture of brushes
3061 G. Marshall—Facilitating the treating or preparing of casks
3062 T. Lancaster—Economising and inducing combustion of fuel in furnaces
3063 J. E. Brown—Apparatus for embossing
3064 E. Farr and I. Gregory—Construction of pianofortes
3065 G. K. Snow—Shirt collars and mechanism for manufacturing the same
3066 G. T. Bousfield—Machinery employed when weaving hair
3067 C. S. Baker—Treating materials for the manufacture of paper
3068 E. Howarth—Apparatus for safety of railway passengers and trains

Dated November 30th, 1865.

3069 A. C. Duncan—Treatment of madder for dyeing and printing
3070 J. T. Hall—Lamps for burning petroleum
3071 W. Thompson—Fining and purifying spirituous liquors
3072 S. Dixon—Manufacture or production of stays corsets, and bodices
3073 J. Kerfoot—Top rollers
3074 J. H. Johnson—Sinking and operating wells
3075 J. Gamgee—Disinfecting stables and cattle sheds
3076 J. Hollands, E. R. Hollands, and T. Hollands—Gold and other ornamental chains
3077 J. L. Norton and J. Landless—Pressure of steam and other fluids
3078 W. Clark—Decolouring sugar and other saccharine matters

Dated December 1st, 1865.

3079 I. M. Singer—Sewing machines and embroidering
3080 J. Roberts—A spoon rest
3081 J. Wilson—Knobs for doors, cupboards, and asphans
3082 W. Pringle—Breech-loading firearms
3083 I. J. Handley and C. Wilkins—Compasses, callipers, and dividers
3084 T. W. Dodds—Manufacture and treatment of railway bars, &c
3085 W. F. Batho—Manufacture of safes
3086 H. Hedley—Sewing machines
3087 W. R. Taylor—Treatment of grain
3088 L. M. Rogers—Preventing water pipes from bursting

Dated December 2nd, 1865.

3089 W. Johnston—Lamps, lanterns, and gas fittings
3090 I. M. Singer—Ocean steamers and paddle wheels
3091 E. Scott—Looms for weaving
3092 A. J. Wright—Ornamentation of glass
3093 T. A. Weston—Apparatus for moving heavy bodies
3094 R. Edmondson—Pickers used in looms for weaving
3095 E. B. Wilson—Improvements in furnaces
3096 E. Morin and R. Schweizer—Swivel snap
3097 R. Cook—Stretcher for umbrellas and parasols
3098 G. Ash—Securing artificial teeth in the mouth
3099 T. Bell—Treating the oxide of iron
3100 A. Nicole—Improvements in carriages
3101 T. N. Bennie—Apparatus for distilling oils
3102 R. A. Brooman—Holder for cigars or pipes

Dated December 4th, 1865.

3103 J. S. Templeton—Power looms for weaving pile fabrics
3104 A. Mackie—Composing type
3105 D. Hall—Manufacture of salt
3106 F. Braby and A. Moore—Construction of metal tanks and cisterns
3107 L. J. Bouchart—Lubrifaction of textile matters and machinery
3108 W. Clark—Ornamental laces and fabrics in twist lace machinery
3109 W. Beardmore—Furnaces
3110 R. A. Brooman—Dyeing and printing
3111 A. Paraf and R. S. Dale—Producing scarlet colours
3112 J. Steart—Production of fibre from various fibrous substances
3113 E. C. Hodges—Breech-loading fire-arms
3114 W. E. Newton—Artificial arms
3115 J. Tomlinson—Disinfectants

Dated December 5th, 1865.

3116 J. J. Ashworth—Winding machinery
3117 P. A. Muntz—Metal tubes
3118 W. S. Clauderay—Leather shaving machinery
3119 R. A. Brooman—Composition applicable to moulding of various materials
3120 S. W. Wilkinson—Cleaning cotton and other fibrous substances
3121 J. Prest, H. Harrison, and B. Roeber—Insulators
3122 J. Toth—Preventing Incrustation in steam boilers
3123 I. Holden—Combing wool and other fibrous substances
3124 W. B. Masters—Pressing shawls
3125 B. Bawden—Bricks
3126 E. A. Cowper—Grinding corn and other substances
3127 G. E. Donisthorpe—Getting coal
3128 E. Vagg—Fire-escapes
3129 E. Headly—Tanks, baths, mangers, and other vessels
3130 A. B. Brown—Steam cranes

Dated December 6th, 1865.

3131 J. Taylor—Railway chair, and in securing rails thereto
3132 J. Walker—Fastenings for waistband buckles and similar purposes
3133 E. Whele—Dressing, sifting, cleaning, and polishing fruit
3134 J. Sainty—Shoeing horses
3135 H. B. Hamilton—Metal bedsteads
2136 T. L. Nicklin—Furnaces used in the manufacture of iron
3137 G. Macdonald—Cleaning cotton
3138 G. DaGs—Locking and unlocking gates on railway crossing
3139 J. H. Pepper and T. W. Tobin—Illusory exhibitions
3140 W. Ennis—Furnaces in which steam is generated
3141 W. E. Newton—Steam boilers
3142 A. C. Bamlett—Reaping machines
3143 N. Salamon and W. J. L. Davids—Sewing machine needles
3144 G. F. Russell—Kitchen stoves
3145 W. H. Clabburn—Shawls

Dated December 7th, 1865.

3146 J. Parkes—Hot water dishes, plates, and other similar articles
3147 W. Grosvenor—Apparatus to aid in the teaching of arithmetic
3148 C. D. Hitchcock and J. Shimmon—Leather-driving belts
3149 W. E. Evans—Harmoniums
3150 G. F. Russell—Dashes of carriages
3151 S. Norris—Breech-loading fire-arms
3152 J. Woollatt—Looms for weaving

Dated December 8th, 1865.

3153 P. de Mondesir, P. Lemaitre, & A. Jullienne—Compressing air
3154 N. J. Holmes—Electricity for testing of torpedo mines
3155 T. Claridge—Rolling gun barrels
3156 O. Maggs & G. H. Smith—Preparing Mogador grasses
3157 W. Calvert and J. S. Robertson—Coats
3158 R. E. Price—Tyres for railway wheels
3159 W. Boulton and J. Worthington—Mortars and similar articles
3160 F. Dahis—Buttons
3161 G. Wailes & B. Cooper—Feeding of scribbling and carding machines
3162 G. T. Bousfield—Cooking by steam
3163 A. Parkes—Preparing gun cotton
3164 G. T. Bousfield—Attaching buttons and ornaments to garments
3165 G. T. Bousfield—Cutting files
3166 E. Watteau—Screwing machine
3167 H. A. Bonneville—Barometers
3168 H. A. Bonneville—Permanent way of railroads
3169 A. Grivel—Strong rooms and other similar depositories

Dated December 9th, 1865.

3170 W. Jackson—Sewing machines
3171 S. Clark—Steering apparatus
3172 A. V. Newton—Preserving animal and vegetable substances
3173 A. Doull—Atmospheric railways
3174 R. A. Brooman—Preparing certain plants for use as tobacco and snuff
3175 S. G. H. D. Gwyn—Covering for protecting the ends of maps
3176 R. Pickup and J. Heald—Communicating between passengers and guard
3177 C. Baylis—Fish-hooks
3178 T. Wilson—Breech-loading fire-arms
3179 A. Barclay—Injecting and ejecting fluids and liquids
3180 W. Boggett—Wire conductors for electro-telegraphic purposes
3181 W. T. Eley—Breech-loading cartridges
3182 J. Warburton—Combing silk and other fibrous substances
3183 E. Morewood—Coating metals
3184 N. W. Wheeler—Steam boilers
3185 R. F. Fairlie—Locomotive engines
3186 H. S. Marshall—Adapting ordinary tables for playing billiards
3187 W. Clark—Cups or sockets applied to candles and other lights
3188 W. W. Hulse—Tools for cutting wood

Dated December 11th, 1865.

3189 T. C. Usher—Cutting paper
3190 V. M. Griswold—Photographic surfaces
3191 J. Townsend—Generating steam
3192 T. Berrens—Laying down submarine cables
3193 J. T. Griffin—Ruler
3194 J. Goddard—Folding shutters
3195 T. King—Pyrotechnic toy
3196 A. V. M. Marie—Teaching and study of musical notation
3197 W. J. Murphy—Apparatus for the working of breech loading guns
3198 E. L. Walker—Elevating hay, grain, or similar materials
3199 W. R. Lake—Permanent way of railways
3200 H. K. York—Finishing rivets
3201 J. Jonas—Waterproof lining of cases

Dated December 12th, 1865.

3202 C. Easby—Truss
3203 J. Kaspary—Compound to be employed as a drinking beverage
3204 R. Hineson—Aerated waters
3205 M. Klotz—Sewing machine shuttles
3206 A. Budenberg—Blasting powder
3207 H. Y. Thompson—Envelopes
3208 C. K. Tomlinson and C. J. Hayward—Sheep ointment
3209 R. Howarth—Stiffening fabrics
3210 L. L. Sovereign—Naves and axle boxes of carriage wheels
3211 R. Beck—Microscopes
3212 J. Campbell, S. McKinstry, and T. Wilson—Preparing flax
3213 J. Stocker—Steam engines
3214 A. V. Newton—Cutting tubes
3215 A. V. Newton—Bolts and rivets

Dated December 13th, 1865.

3216 G. Barber—Door mats
3217 J. H. Smith—Sewing machines
3218 F. B. Doering—Machinery for boring rock and other mineral
3219 R. A. Brooman—Manufacture of pulp from lygeum spartum
3220 H. F. McKillop—Cleansing ships' bottoms
3221 B. Porritt and W. Priestley—Cleansing of woollen yarns
3222 W. Brookes—Obtaining motive power
3223 G. Atkin, E. Atkin, and A. A. Atkin—Grinding saws
3224 J. Sanderson—Railway bars
3225 P. Gardner—Rotary engine
3226 P. W. Bowen—Cultivating land by steam power

Dated December 14th, 1865.

3227 A. E. Dobbs—Drag for carriages
3228 H. Prowse—Felt
3229 C. P. Button—Swings
3230 A. Guye—Keyless watches
3231 W. Winter—Bearings of pulleys
3232 J. S. Watson—Propelling ships
3233 T. R. Hetherington and S. Thornton—Cleaning cotton
3234 J. Elce and R. Cotton—Machines used in spinning and doubling
3235 J. C. Wilson—Generating steam
3236 R. A. Brooman—Regulalating the tension of threads in weaving
3237 J. Masson—Apportioning the fodder of horses and cattle
3238 W. Pretty—Stays and corsets
3239 H. W. Miller—Screening grain
3240 W. R. Lake—Applying wax to the threads used in sewing machines
3241 J. Laucaster—Seamen's hats
3242 H. G. Fairburn—Compressing coal
3243 W. Robinson—Mixing materials
3244 H. Negretti and J. W. Zambra—Obviating the bad consequences of railway accidents
3245 W. A. West—Paper pulp

Dated December 15th, 1865.

3246 C. de Bergue—Bridges and viaducts
3247 G. Warriner—Furnaces
3248 T. Parker—Light applicable to photographic and other purposes
3249 J. Aston—Breech-loading fire-arms and ammunition for the same
3250 C. Blyth—Holders for hacking machines for fibrous substances
3251 H. C. Litchfield—Machinery or apparatus for cutting bread
3252 F. Walton—Floor cloth and in apparatus employed
3253 R. Ransford—Bichloride of carbon and chloride of sulphur
3254 R. Badger—Shears and scissors

Dated December 16th, 1865.

3255 T. Jones and J. Buckley—Bed quilts and toilet covers
3256 C. Pengilly—Treatment of sulphurous and arsenical pyrites
3257 F. Johnston and W. Astley—Utilising waste healds for weaving
3258 A. V. Newton—Fire-arms and in cartridges to be used therewith
3259 J. A. Longridge—Locomotives
3260 C. L. W. Reade—Obtaining motive power applicable to various purposes

Dated December 18th, 1865.

3261 S. Whitehouse, S. Whitehouse, jun., J. Whitehouse, and W. Whitehouse—Collecting waste gases arising from blast furnaces
3262 W. E. Dobson—Conversion of starch refuse into useful gumaline
3263 J. F. Dickson and J. Barrs—Utilising scraps or small pieces of leather
3264 J. Harcourt—Lacquering metal goods
3265 C. Liddell and R. S. Newall—Mooring floating structures
3266 O. C. Burdict—Metal nuts
3267 H. C. Ensell—Smelting copper
3268 H. Planck—Regulating heat obtained by the combustion of gas
3269 R. A. Brooman—Boilers or apparatus for generating steam

Dated December 19th, 1865.

3270 J. Bolton—Rendering boots waterproof
3271 G. S. Harrison and S. E. Featherstone—Pedal accelerator
3272 J. W. Carr—Applying rotary motion
3273 A. H. Thurgar—Foot protectors
3274 J. T. Dawes—Locks and latches
3275 C. A. McEvoy—Igniting shells and similar projectiles
3276 W. Creasy—Machinery for drying and bleaching grain
3277 G. T. Bousfield—Splitting leather skins and similar articles
3278 E. A. Caua—Projectile for rifled ordnance or cannon
3279 J. H. Johnson—Pistons
3280 L. Duraud—Dyeing and printing
3281 W. E. Newton—Felt hats
3282 A. V. Newton—Electro-magnetic engines
3283 W. Clark—Aerial navigation
3284 W. Clark—Repeating fire arms

Dated December 20th, 1865.

3285 J. Gibbon—Retort for extracting products from cannel coal
3286 W. Kerr—Novel optical arrangement by which a new scenic effect is produced
3287 J. J. Harrison and E. Harrison—Deodorising impure air
3288 J. Birch—Steel
3289 T. Rickett—Metal tubes for gun barrels and other purposes
3290 J. Martin—Door locks
3291 M. Siegrist—Signalling on railway trains
3292 W. Clark—Ventilating rooms
3293 J. Gamgee—Preservation of meat
3294 R. M. Claypole—Castors
3295 F. L. Hancock and C. L. Hancock—Propellers for ships
3296 J. Watson and J. Player—Obtaining oil from bituminous shalt
3297 W. F. Cooke—Cutting slate
3298 H. E. Newton—Preventing ladies' dresses from trailing the ground

Dated December 21st, 1865.

3299 W. Boggett—Wire conductors for electro-telegraphic purposes
3300 H. A. Bonneville—Steel
3301 V. P. P. van Leur—Envelopes
3302 W. Barnsley—Securing the ends of strapping employed in machinery
3303 G. Davies—Gas-burner
3304 W. E. Newton—Cartridges for breech-loading
3305 J. W. Blackman—Fireproof safes
3306 G. Hawksley—Constructing the treads of steps or stairs
3307 W. E. Laycock—Looms for weaving

Dated December 22nd, 1865.

3308 W. Clark—Steam engines
3309 R. Newhall—Cases for needles
3310 M. D. Rosenthal and S. Gradenwitz—Imitation of ivory
3311 L. D'Aubreville—Weaving two separate cloths at one and the same operation
3312 D. McGrath—Treatment of fixed oils
3313 J. Anderson—Cleansing ships' bottoms
3314 E. Deane—Masts
3315 W. Jackson—Pumps
3316 W. E. Newton—Astronomical instruments
3317 G. Davies—Burning combustible vapours
3318 J. A. Cooper—Yarns
3319 G. T. Bousfield—Forming articles of sheet metal

Dated December 23rd, 1865.

3320 W. Smith—Trimmings
3321 S. Chatwood—Safes
3322 H. A. Dufrene—Permanent way of railways
3323 E. Clifton—Caps employed in spinning
3324 J. Groves and G. Robinson—Locks
3325 W. E. Newton—Preparing glue
3326 R. M. Marygold and S. Fitzjohn—Hanging window sashes
3327 J. Jeffreys—Furnaces
3328 E. Dwyer—Water as a motive power
3329 J. C. Haddan—Theodolites
3330 H. D. Hoskold and W. Br Braiu—Pumps
3331 F. Jenner—Envelopes
3332 F. W. Webb—Crossings for railways

TYRE ROLLING MACHINE.

FIG. 1, SECTION.

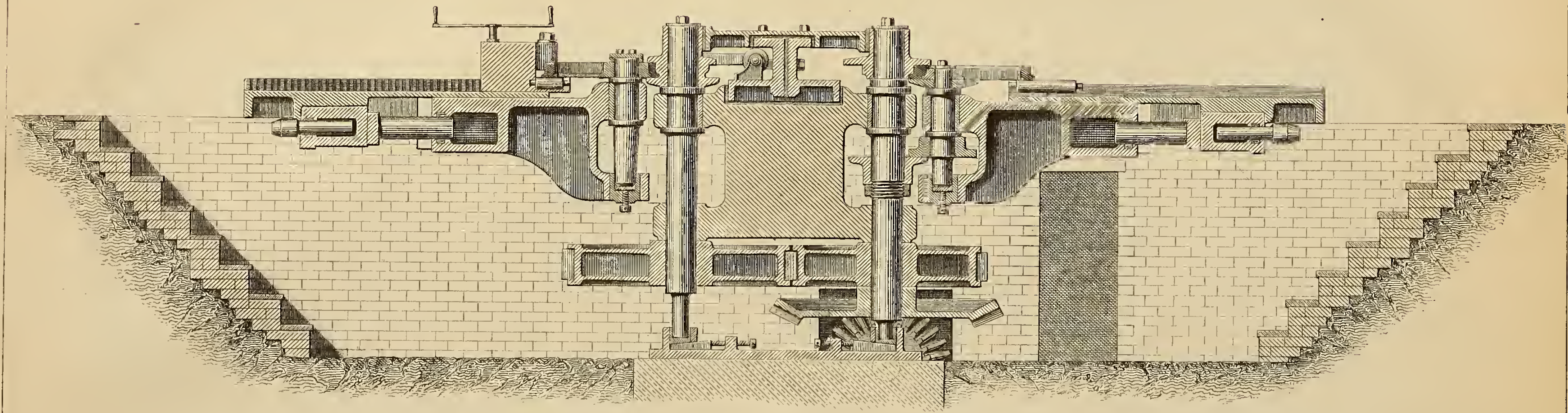
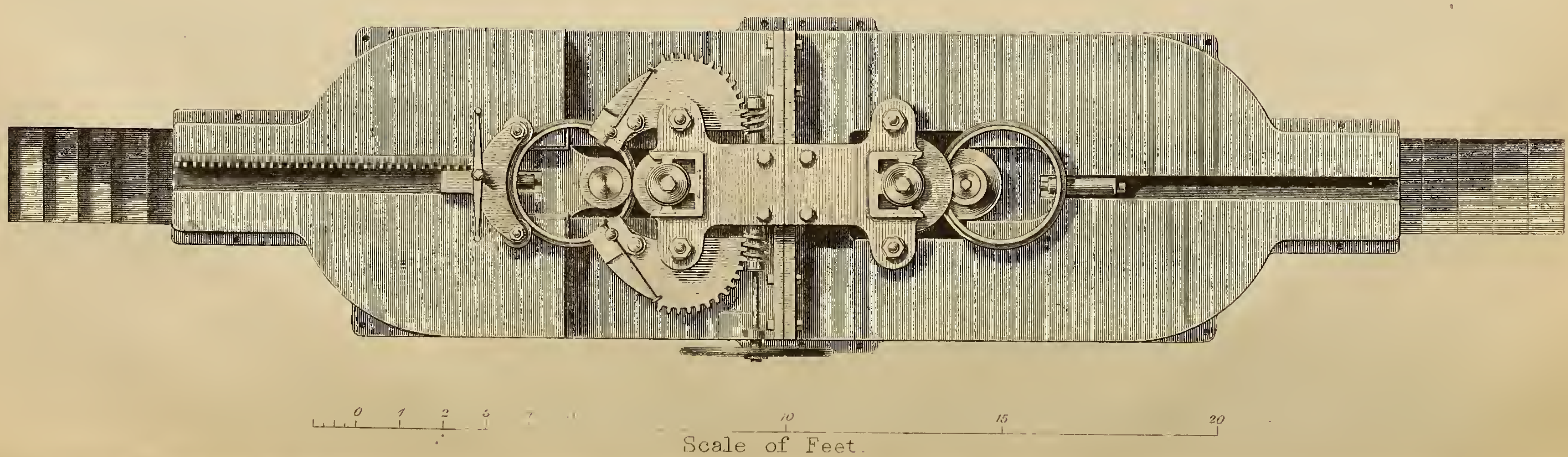


FIG. 2, PLAN



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WORKSHOP MACHINERY.

Tyre Rolling Machine.

(*Illustrated by Plate* 295.)

The great and increasing amount of wear to which the tyres of railway wheels are subjected, demands that no care be spared to manufacture them in the best manner, and of materials possessed of strength and durability commensurate with the work to be done by it. The importance of paying due attention to the construction of wheel tyres is amply evidenced by the disastrous accidents which have accrued from their occasional failure. In order to attain the most satisfactory results, it is necessary that the tyres should be formed without a weld, and in plate 295 we illustrate a section and plan of a machine designed for rolling solid or weldless tyres, which is manufactured by Messrs. Collier and Co., of Greengate Mills, Salford, Manchester.

This machine consists of a strong framework carrying two sets of rolls, with the necessary gearing to transmit motion to them. The set of rolls shown at the right hand end of the frame roughs out the tyre from the bloom, and it is finished in the rolls shown at the left hand end of the frame in the plate.

When the blooms come from the hammer they are first placed between the roughing out rolls, and operated upon by them until they are reduced to within a few inches of the size required, after which they are moved over by an hydraulic or lever crane to the finishing rolls by which they are brought to the exact size and section determined upon, being left perfectly true so as to render turning unnecessary.

Motion is imparted to the machine by a pair of high pressure horizontal steam engines of sixty horse-power. These engines are placed underground, and through the bevil wheel, of which a portion is visible in the section at the bottom of the driving shaft of the roughing out rolls, transmit motion to the larger bevil wheel keyed on to that driving shaft. The finishing rolls are driven from the roughing roll shaft by means of the toothed wheels shown in the section just above the large bevil wheel described.

The moving rolls at each end of the machine are actuated by hydraulic pressure in order to get the force necessary to compress the metal into the requisite section as it passes the rolls. Each moveable roller is carried in a sliding frame, as shown, through which frame the pressure is put upon the rolls by means of the hydraulic apparatus now to be described.

An hydraulic cylinder is cast in each roll slide, the water through which the pressure is imparted being caused to pass through the centre of the ram to impart force to the rolls, and there is also a cylinder to bring the slide back, so that the tyre may be removed when rolled. The cylinders for bringing back the roll slides are of smaller diameter than those for imparting the pressure to the rolls, in order that they may act more rapidly.

The hydraulic power is obtained from a pair of pumps furnished with large and small plungers. The large plunger is only used for the quick motions of the roll slides, and automatically disengages itself as soon as the pressure comes on, after which the slide is moved forward to its work by the action of the small plunger. These pumps are driven by a pair of steam cylinders attached to the pump cistern.

Above the ground and by the side of the machine are placed the hydraulic reversing valves, by means of which, by a simple movement of the hand the massive slides are caused to move backwards and forwards with the greatest ease and rapidity.

The steam valves which regulate the motion of the large and small engines are also placed in close contiguity to the hydraulic valves, so that the whole machine is brought entirely under the control of one man.

The finishing rolls are furnished with supplementary rolls designed to render the tyre perfectly true as to its circularity, and with top and bottom rolls to form the edges of the tyre at the same time. All these rolls are put into operation by one man by means of the large hand-wheel at the side of the machine. While the tyres are undergoing the process of rolling, the edges most distant from the rolls are supported upon small rollers fitted in the framing of the machine, as shown in our illustration.

The driving shafts of the rollers are carried in strong bearings at the upper part, situated just beneath the rolls, and in step bearings at the bottom. These latter are furnished with wedges placed beneath them, and acted upon by set screws, whereby they are raised when necessary to compensate for wear and maintain the rolls at their proper height. The moveable rolls are similarly mounted in the sliding frames, but they have no wedges under the bottom bearings, which are raised when necessary by the direct action of set screws. In this case wedges are not required, as the weight upon the lower ends of the shafts is inconsiderable in comparison with that upon the ends of the driving shafts.

Among the advantages of this machine the following appear to us to be worthy of especial attention: —

By constructing the machine with two pairs of rolls, great facilities are afforded for rolling the blooms to any section which may be most suitable for forming the flange in the finishing rolls, thus obviating the necessity otherwise existing of having the flange previously hammered on.

Usually in rolling large tyres from small blooms in machines fitted with only one pair of rolls, the flange is unavoidably drawn more than the other parts of the tyre; hence it is rendered too thin, and has not sufficient metal to fill up the flange space in the rolls; but when the machine described above is employed the flange can be left larger in the roughing out rolls than its intended finished size, so as to allow sufficient material for the flange to be ultimately rolled of its full size and sound.

The rough work being done in one pair of rolls, and the finishing in another enables the latter to be maintained in good condition so as to insure the proper finish being given to the rolls without edges or other imperfections being left on the tyres which would require to be chipped off.

The whole machine being easily worked and under the complete control of one man, with such a powerful agent as hydraulic pressure, the work is rendered much less laborious, it is executed more quickly, and the number of workmen requisite is reduced, whereby expense is saved.

A tyre 8ft. in diameter made of Bessemer or other steel can with facility be rolled at one heat in Messrs. Collier's machine.

ON STEAM AS THE MOTIVE POWER IN EARTHQUAKES, VOLCANOES, &c.

By R. A. Peacock, Jersey.

(*Extracts from an unpublished MS.*)

An initial force of 237½ tons per square inch may be taken as a fair representation of the average effects of volcanoes. That is to say, it would propel a mass of granite 9ft. thick from a supposed focus at three miles below sea level up to one mile above sea level—total, four miles of vertical height. Of this force considerably more than one-half would be expended in overcoming the resistance of the atmosphere.

Can there really be any reasonable doubt that steam is capable of exerting a much greater force than this after the perusal of these papers, especially the two previous ones in June and November? Every reader will, of course, judge for himself; but, for my own part, I long ago arrived at the conclusion that steam has amply sufficient power to cause the greatest effects observable, and that OTHER FORCES CO-OPERATE WHERE NO HELP IS REQUIRED. This was illustrated last month by showing that the late accident at Erith would still have been a *gunpowder* explosion, even if there had been a little gun-cotton in each magazine. There is no risk of attempting to prove too much in these papers, because the greatest amount of steam power contended for, as it happens, is only about enough to account for the tremendous convulsions of the coal period.—See *Siluria*, 1859, p. 529, &c. Evidence No. 56 following would seem to have required nearly the maximum force of steam for which these papers contend.

I.

The Contact of the Metalloid Bases with Water and Air may be a co-operating cause in Earthquakes and Volcanoes.

"The nucleus of our planet is supposed to consist of unoxidised masses, the metalloids of the alkalies and earths. Volcanic activity is excited in the nucleus by the access of water and air. *Volcanoes certainly pour forth a great quantity of aqueous vapour into the atmosphere*, but the assumption of the penetration of water into the volcanic focus is attended with much difficulty, considering the opposing pressure of the external column of water and of the internal lava; and the deficiency, or, at all events, very rare occurrence of burning hydrogen gas during the eruption (which the formation of hydrochloric acid, ammonia, and sulphuretted hydrogen certainly does not sufficiently replace) has led the celebrated originator of this hypothesis (Sir Humphrey Davy) to abandon it of his own accord."—*Bohn's Cosmos*, vol. v., pp. 169, 170.

"Whilst Davy in the most distinct manner gave up the opinion that volcanic eruptions are a consequence of the contact of the metalloid bases with water and air, he still asserted that the presence of oxidisable metalloids in the interior of the earth, might be a co-operating cause in volcanic process already commenced." — *Bohn's Cosmos*, vol. i., p. 234, quoted at p. 170, vol. v.

Gay Lussac thinks that "the penetration of sea water does not appear to him to be improbable under certain conditions."—Foot note to *Bohn's Comos*, vol. v., p. 169.

It is well known that the late Baron Humboldt examined more volcanoes than perhaps any other man ever did, and that he experienced some earthquakes in South America and in the east. His "difficulty" aforesaid, besides being answered by himself in the same sentence, is also answered by him in No. 52 following, by what he aptly calls "a very striking proof" of water having got down to a volcanic focus. Water *must* get down to a volcanic focus, because we shall often find steam and hot water coming out again.

II.

Ejections of Steam or Aqueous Vapour from Volcanoes.

1. Sir Humphrey Davey says, the volcanoes of Central America give out *aqueous vapour in very large quantity*, as well as certain gases.—*Lyell's Principles of Geology*, 1853, p. 549.

2. In the explosion of the volcanic mountain Cosiguina in Central America, there was a noise as of many cannon from various parts of the Gulf of Fonseca. An enormous coal black cloud of smoke rolled high above the summit of the volcano. This cloud was fine ashes so abundant as to produce darkness. There was a tremendous subterranean report as of a thousand cannon, heard at several hundred miles distance. The eruption was most violent for three days. *Clouds of steam* continued to rise from the volcano for months after. The eruption commenced January 20, 1835.—*Travels in Central America*, by Dr. Carl Scherzer, vol. ii., p. 224, &c.

The four following evidences are from Sir Charles Lyell:—

3. At the great eruption of Skaptár Jokul in 1783, in some places where the *steam could not get vent*, it blew up the rock, throwing fragments to the height of more than 150ft. About a month previous to the eruption on the main land, a submarine volcano burst forth in the sea, and a new island was thrown up (which volcano must *necessarily have produced steam*); the island was named by the King of Denmark, Nyöe, or the New Island, consisting of high cliffs, but before the end of a year nothing was left but a reef of rocks from 5 fathoms to 30 fathoms under water. (This is similar to what took place at Graham Island, see post No. 50.) Earthquakes, which had long been felt in Iceland, became violent on the 11th of June, 1783, when Skaptár Jokul on the mainland, distant nearly two hundred miles from Nyöe, threw out a torrent of lava.—*Principles*, p. 425.

Besides proving the existence of steam, this proves two other things, namely, that the *same* causes operate both in earthquakes and volcanoes. And secondly, that there may be cavities, or at all events, fissures or communications continued through the great distance of two hundred miles. The like may be gathered as to distant communications underground from Nos. 24 and 58.

4. "*Aqueous vapour* constitutes the most abundant of the aëriform products of volcanoes in eruption."—*Principles*, p. 553.

5. "We know that volcanoes in eruption not only emit fluid lava, but *give off steam* and other heated gases, which rush out in enormous volume, for days, weeks, or years, continuously, and are even disengaged from lava during its consolidation."—*Lyell's Manual*, p. 601. (Ed. 1855.)

I believe in the soundness of the following, which Sir Charles Lyell suggests as a speculation; it is quoted from his *Principles of Geology*, p. 558. He says:—"In speculating on the mechanism of an ordinary volcanic eruption, we may suppose that large subterranean cavities exist at the depth of some miles below the surface of the earth, in which melted lava accumulates; and when water containing the usual mixture of air penetrates into these, the *steam* thus generated may press upon the lava and force it up the duct of a volcano, in the same manner as a column of water is driven up the pipe of a geyser."

6. Sir Charles quotes Sir H. Davy as stating that the subterranean cavities of Vesuvius *threw out large volumes of steam* during an eruption. —*Principles*, p. 550.

7. Schmidt saw clouds of volcanic smoke and *steam*, which encompassed his observatory on Vesuvius during the great eruption of 1855.—*Intellectual Observer*, vol. i., p. 149.

8. Whoever has seen the blowing off of steam from a boiler will probably recognise Sir William Hamilton's "mass of smoke like whitest cotton," in the following abstract, as steam. This opinion is corroborated by the latter part of No. 50 following.

Sir William says that for two years previous to the eruption of Vesuvius in 1779, its top had never been free from smoke. On August 5th he saw *a mass of smoke like whitest cotton* issue, four times as large as the mountain itself, which is 3,700ft. high; stones, scoriæ, and ashes shot up at the same time 2,000ft.; at times heavy, liquid lava poured over the sides of the crater. On August 8th there was a loud report, and instantly a column of liquid transparent fire rose as high as the mountain itself; puffs of very black smoke accompanied, and at the same moment could be seen bright electrical fire playing briskly in zig-zag lines. On August 9th there was a *subterraneous boiling noise*, and smoke of two sorts, *white as snow* and black as jet, the black being scoriæ and minute ashes. Very large stones mounted to an immense height, forming parabolas, leaving a trace of white smoke. Some burst like bombs, others burst into

a thousand pieces soon after emission. On August 11th the last explosion came, and gradually increased, being louder than any before. *A mountain of white cotton-like clouds* rose to an extraordinary height, and formed a colossal mass indescribably great.—*Phil. Trans. R.S.*, 1780, vol. xiv., p. 163, &c.

May we not conclude that on this last day Vesuvius was blowing off its steam, its business being finished for the time? Sir William made his observations from Pansilippo through a good telescope. He was not on the spot so as to ascertain whether the "white smoke" was steam or not.

9. Mr. William Smith, C.E., F.G.S., proprietor of The Artizan, has lately visited Vesuvius and Etna, and says, in answer to a question in a letter dated June 23, 1865, "he thinks steam *is* generated during volcanic action, and is a material agent in the production of those explosive effects which are observable both at Etna and Vesuvius."

10. Mr. J. J. Jeans, British Vice-Consul at Catania, says, in a letter dated in Feb. 4, 1865, "A deplorable accident has happened at Etna by an explosion caused by the contact of *burning lava with some cistern or watercourse*, by the effects of which a number of Sappers have lost their lives, but the particulars are not known."—*Illustrated London News*, Feb. 25, 1865.

Here we have a distinct proof of lava converting water into steam, and causing a destructive explosion.

11. M. Fonqué has communicated to the Academy of Sciences an account of his recent ascent of Mount Etna. He states that the eruption of February, 1865, has not materially changed the configuration of the great crater. . . . It is only towards the south that he found fissures from which were issuing torrents of suffocating fumes *composed of steam* charged with sulphuric and hydrochloric acid, the latter predominating. He found a "fumerolle" with a temperature of 203° centigrade, which is equal to 397·4° Fahr.

12. From *Art and Nature under an Italian Sky*, 1850, p. 110, published anonymously, we gather that just as the author reached the base of the cone of Vesuvius a magnificent explosion took place. The sound had often been compared to the firing of artillery, but he thought a much more apt comparison was the *bursting of an immense steam boiler*. A vast quantity of red-hot stones was projected, some of them to the height of 300 feet. *The projecting force is evidently steam*, he says, *from the appearance of the vapour and the shower of hot water which falls around.*

13. In a recent eruption of Mount Vesuvius, *aqueous vapour* and storms of ashes issued. At Torre del Greco a sea whirlpool of 360ft. diameter was boiling violently and emitted a strong sulphurous odour: the sounding was 23 fathoms. The principal development was carbonic acid gas.—*Morning Advertiser*, Dec. 28, 1861.

Was the water descending by the whirlpool to the volcanic focus?

14. Von Buch found that in a crater in the Canary Islands, were open fissures out of which hot vapours rose which in 1815 were 145° F., and were probably at boiling point lower down. The exhalations appeared to be *aqueous vapour*, but they could not be pure steam, for the crevices were incrusted with siliceous sinter.—*Principles*, p. 438.

15. From near the centre of the volcanic mountain Bromo in Java (see Voyage of H.M.S. *Fly*, vol. ii., p. 68), rises a rough conical mound, 600ft. or 800ft. high, having on one side a number of subordinate craters. One of these had been frequently active in 1845 when Mr. Jukes visited it, and was then belching out *much smoke and steam*, with a great rumbling noise proceeding from the depths of the great funnel-like crater.—*Jukes's Manual of Geology*, 1857, p. 290.

16. James D. Dana, the geologist of the United States exploring expedition, says vol. x., p. 368, "That the ordinary eruptions and usual action of a volcano proceed principally *from water gaining access* to a branch or branchlets belonging to a particular vent, and not to a common channel below: *the fresh waters of the island are the principal source of the vapours* (evidently steam*) of Kilauea." This is one of several deliberate conclusions which Mr. Dana arrived at.

* The words "evidently steam" have been inserted by the present writer, not by Mr. Dana.

17. Mr. Coan was present in December, 1864, at the eruption of the volcano of Kilauea in one of the Sandwich Islands. He spent a night near a beautiful pit crater called Napau, nearly circular, about 300ft. deep, a mile perhaps in diameter, and with a bottom of sand so smooth and hard that a regiment of cavalry might be reviewed there. One eighth of a mile from this crater fissures are opened in the earth, *out of which scalding steam and smoke have issued from time immemorial*, and affording heat enough to cook for an army.—*American Journal of Science*, quoted in *Illustrated London News*, Oct. 28, 1865, p. 415.

18. The island of Hawaii, formerly called Owhyhee, is an immense volcano of 4,000 square miles, its summit Mowna Roa being 16,000ft. high. *Volumes of smoke and steam* were ascending from the vents, but as the evening closed, fire after fire appeared glimmering through the vapour; *some of the cones were ejecting fragments of rock*; others ashes, lava, and *boiling water*.—*Gallery of Nature* p. 210. *Mantell's Wonders of Geology*, p. 724, &c.

19. "Chimborazo throws out *masses of mud* and elastic fluids."—*Cosmos* vol. v., p. 336.

Note.—Mud implies the presence of water.

III.

Earthquakes are actually fed by Water.

20. In a paper read by M. Pissis before the French Academy, see *Compte's Rendus*, Jan. 27, 1862, he says, "it is generally believed in the districts of S. America which are most subject to earthquakes, that *those disturbances occur during the rainy season*, and up to the period of drought." During twelve years of his own residence on the spot this theory held good; and *the years of most violent rain* were *distinguished by a great number of earthquakes*.

IV.

Active Volcanoes are actually fed by Water.

21. Mr. Dana and Dr. Junghuhn say that the volcanoes of the Pacific Islands, however large, *however much exposed to heavy rains, support no rivers*, so long as they are in the process of growth, or *whilst the highest crater emits showers of scoriæ and floods of lava*. The ejected matters are very porous.—*Lyell's Manual*, 1855, p. 497.

22. The like is true of Etna, for we read as follows:—"An unusual silence prevails on the Val del Bove, Etna; for there are not torrents dashing from the rocks, nor any movement of running water in this valley such as may be almost invariably heard in mountainous regions. *Every drop of water that falls from the heavens, or from the melting ice or snow, is instantly absorbed by the porous lava*."—*Principles*, p. 405.

"Running water in general exerts no power on Etna, *the rain which falls being immediately imbibed by the porous lava*, so that vast as is the extent of the mountain, it feeds only a few small rivulets, and even these are dry during the greater portion of the year."—*Principles*, p. 411.

23. It often happens that *a lake which has endured for centuries* in a volcanic crater, *disappears suddenly on the approach of a new eruption*. —*Principles*, p. 389.

24. It is well known that on the shores of the island of Cephalonia there is *a cavity in the rock into which the sea has been flowing for ages*, and many others doubtless exist in the leaky bottom of the ocean. The water, perhaps, being *converted into steam and escaping upwards*. *Principles*, p. 389.

Note.—Cephalonia is 300 miles distant in a direct line from Etna, and from the stufas of the Lipari Isles, and 360 miles from Vesuvius, which appear to be the nearest vents. There may, therefore, be a cavity or cavities extending for either of these distances.

V.

Rocks ejected from a Volcano by Steam.

25. Speaking of the angular masses of the agglomerate of the Caldera of Palma, Sir Charles Lyell says that "the only cause he knows capable of dispersing heavy fragments of 3ft., 4ft., or 6ft. in diameter, without

blunting their edges, *is the power of steam;* unless, indeed, we could suppose that ice had co-operated with water in motion, and the interference of ice cannot be suspected in this latitude (28° 40′ N.), especially as he looked in vain for signs of glacial action here and in the other mountainous regions of the Canary Islands.—*Manual*, 1855, p. 503.

VI.

DEPOSITS OF WATER, AND OF ICE AND SNOW, READY TO DESCEND INTO VOLCANOES BY GRAVITATION THROUGH THE POROUS STRATA.

26. "At Volcan d'Ansango are *two chasms filled with water.*"—*Cosmos*, vol. v., p. 336.

27. There are *several marshes* and *two small lakes* in the long and broad ridge which unites the volcanic mountains Cotopaxi and the Nevado de Quelandana.—*Cosmos*, vol. v., p. 339.

28. In the crater of the volcano of the Island of S. Lucia are *several small basins periodically filled with boiling water.*—*Cosmos*, vol. v., p. 422.

29. The thirty-eight considerable volcanoes of the Isle of Java are remarkable for the quantity of sulphur and sulphurous vapours discharged. They rarely emit lava, but *rivers of mud issue from them.* The crater of Taschem contains *a lake ¼ mile long* strongly impregnated with sulphuric acid.—*Principles*, p. 353.

30. The Persian volcano, Demavend, *is covered with perpetual snow.*—*Cosmos*, vol. v., p. 361.

31. Two volcanic mountains, Petschan and Hotshen, of Turfan (Asia), are separated by a gigantic block of mountains 420 miles long, *crowned with eternal snow and ice.*—*Cosmos*, vol. v., p. 360.

32. The most extensive, and, probably, the latest pre-historical eruptions of Ararat, *have all issued below the limit of perpetual snow.*—*Cosmos*, vol v., p. 361.

It is obvious that in the many other cases where volcanoes have their tops higher than the limit of perpetual snow, there is a means of producing steam ready to descend. And it ought not to be forgotten that nearly all the volcanoes in the world, are either in the bed of the Pacific Ocean, or in its islands, or not far distant from its shores, and they are doubtless fed by its waters directly, or by its rains indirectly.

VII.

EJECTIONS OF STEAM FROM GEYSERS.

33. "*Steam is exclusively the moving power* in the geysers of Iceland."—Lyell's *Principles of Geology*, p. 553.

34. It has more than once happened *after earthquakes* (in Iceland) that *some of the boiling fountains* have increased or diminished in violence or volume, or entirely ceased, or that new ones have made their appearance."—*Ibid.*

Note.—Does not this prove the connection of geysers and earthquakes?"

35. "*Steam of high temperature* has continued for more than twenty centuries to issue from the 'stufas' of Italy," and "many craters emit hot vapours in the intervals between eruptions, and solfataras evolve incessantly the same gases as volcanoes," proving them to have one common origin."—*Ibid*, p. 546.

36. At the foot of Sulphur Mountain, in Iceland, *steam issued from all parts.* There was a caldron of boiling mud fifteen feet in diameter; near this was an irregular space filled with water boiling briskly, and at the foot of the hill *steam rushed with great force from* among the loose fragments of rocks.—Sir George Mackenzie's *Travels in Iceland.*

37. Such is the *explosive force of steam of the Great Geyser* of Iceland, that very hard rocks are sometimes shivered by it into very small pieces.—*Principles*, p. 554.

38. At the geysers near San Francisco Bay, California, the air is strongly flavoured with sulphur, and the water is strongly ferruginous. There is an alkaline spring surrounded with jets of sulphur, and deposits of magnesia, Epsom salts, and various alkaline mixtures. You hear boiling springs, aud are *half choked with steam.* A horrible mouth in the black rock belches forth tremendous volumes of sulphurous vapour. The waters boil in mad fury, the temperature is about 500°. An egg dipped in is taken out boiled. *The steam rushes from the largest vent hole with such force, and heated to such a degree, that it first becomes visible only at the distance of 6ft. from the earth.* It rises to the height of 80 feet.—*Home and Abroad*, second series, by Bayard Taylor, p. 81, &c.

39. It is said of a mud volcano, about 150 miles from the head of the Gulf of California, that those only who are familiar with the *wild rush of steam* can realise the rude sounds of the mud explosions. *The steam jets issue* from conical mounds of mud of from 3 to 15ft. high; from some *the steam rushes in a continuous stream;* in others, the action is intermittent, *each rush of steam* being accompanied by a shower of hot mud, sometimes thrown to a height of 100ft. These discharges take place every few minutes. The volcanic action has been more violent at a former period, as is proved by the traces of former eruptions, and fragments of pumice stone scattered about the plain.—*John A. Veatch, M.D., Titan*, April, 1859, p. 465, &c.

I endeavoured, in citing these evidences, to classify volcanoes, earthquakes, geysers, hot springs, &c., each under different headings. But they *would* commingle with each other, especially in what follows, and they *thereby prove that they have all one common origin, namely, steam.*

RECENT IMPROVEMENTS IN MARINE ENGINEERING.

This subject, a most important one, doubtless, to our readers, and especially to those more directly connected with marine engineering and steam navigation, has been handled in a very creditable manner by Mr. Charles Smith a short time since, in the paper following his opening address as president of the Association of Assistant Engineers in Glasgow. He states that though he has adopted the title given, it must not therefore be supposed he is also to use the trite phrase, and say that he is almost overwhelmed with the great advances that have been made in marine engineering within the last ten years, for really, although the efforts towards improvement have been innumerable, and acting in almost every available direction, yet, unfortunately, the success that has attended these efforts has been very limited indeed. Whatever may be the cause of this, it is certainly not that there is no room for improvement, for that, in this respect, there is still a vast field for the marine engineer is known to the merest tyro. We find these efforts towards improvements displayed in the almost endless variety of the marine engine. We have in paddle engines the side lever engine, now, however, fast falling into disuse, the oscillating, the diagonal direct acting engine, the trunk, and the steeple engine. For screw engines we have the inverted cylinder engine, the direct acting horizontal, the horizontal return connecting rod engine, the trunk engine, and, lastly, the geared engine, which last, in fact, any one of the screw engines enumerated may be, but which is a kind of engine that is also fast falling into disuse, although, like the side lever paddle engine, it has its own peculiar advantages which its advocates will be loth to sacrifice. The internal arrangement of gearing in many ways may be considered the best form of this kind of engine. The engines which have been enumerated for paddle and screw ships are the best known as being the most extensively used, but are far from including the whole of the varieties that have been from time to time introduced, the greater number of which are designed for the purpose of getting rid of the disadvantages attending some other class, an object that is often obtained with the creation of a new deformity that makes the newer engine the very reverse of an improvement. And seeing that such is the case, it would be useless and unprofitable to endeavour to describe the different kinds of engines employed for marine purposes. But rather let us examine the engines of those makers who, by the adoption of other principles than those involving mere differences in arrangement, have been able to effect improvements much greater in importance than attention to form alone can ever hope to effect. And even in its best form the marine engine, or rather the steam engine, is a most wasteful machine, when we consider that 9-10ths of the heat developed in a furnace (or which ought to be developed) is absolutely lost to us, and only the

remaining fraction utilised, and an equivalent in power obtained from it. That this statement is correct the valuable researches of Joule in thermodynamics go far to prove. It may be tbat we are on the wrong track altogether, and instead of endeavouring to obtain the equivalent of heat in power through the medium of water, tbat we should be rather obtaining that power by more direct operation on the heat itself. Be that as it may, it certainly will not he very surprising if, in the next century, our modern steam engine be considered a more antiquated and wasteful machine than we have ever regarded the Savery or Newcomen engines.

To deal with the marine engine as we have it, however, we find that the best results, that is the most economical results, have attended tbe productions of those engineers who have adopted as improvements the use of high pressure superheated steam used expansively in jacketed cylinders and condensed in surface condensers. Indeed, it will he shown that the adoption of the snrface condenser, or an equivalent to it, is rendered an almost absolute necessity for engines using a high steam pressure.

But to commence with the boilers of marine engines, of which in a paper such as this there is really little to say further than that there has been little or no improvement of a permanent character that has been successfully applied to any of the various kinds of them. We find, however, that the tubular boiler being now so generally adopted, we may consider it to be the boiler best suited for marine purposes. Tbe grand principle to be attended to in all boilers is one too often neglected, viz: that the boiler be of snch an internal arrangement as will best promote the most rapid circulation of the water, by which not only is the value of tbe heating service much increased, but the boiler plates are rendered less liable to be overbeated. Perhaps there have been more attempted improvements on boilers, however, in the way of smoke consuming than in any other way; but we may call the results of all attempts failures so far, seeing it has been found that the admission of cold air for the purpose of burning the smoke has, in an economical point of view at least, proved to be injurious rather than heneficial, and it has been in this direction that most smoke-buruing apparatuses have tended. And all that can yet be said of smoke hurning is that it can be best effected on a well-constructed fire-grate, by careful firing, with plenty of space between the bars for the admission of air. Tbe result of a deficiency in the latter respect is the formation of carbonic oxide, which is often seen in flame at the mouth of the funnel, where it catches fire on meeting with the oxygen of the air in its exit.

The author states, the most perfect smoke-consuming furnace he had yet seen was that according to Wilson's patent, a furnace with which he had something to do in adapting it to steam boilers. It may, with some modifications, be yet adopted for marine pnrposes, witb great economy only, however, for those working witb low pressures. Besides being a smoke consumer, it likewise possesses the double advantage of being a self-feeder, requiring little or no attention from the fireman, and the ashes only requiring to be removed every two or three days. These are advantages that would be of greatly increased value at sea. This furnace, however, requires to be considerably modified and improved before it can be confidently applied to marine boilers.

With regard to superheated steam, we may say that although it has proved of considerable value, and now extensively adopted, still the great results that at one time were expected to follow its adoption have never been realised, it being then considered that the higher the temperature to which steam of any pressure was brought the greater would become its expansive properties.

It has now been found, however, that very hot steam, that is to say steam exceeding 350° temperature, sets in operation an internal corrosion in the superheating pipes or cbambers, besides occasioning a softening of the valves, faces, and cylinder, whereby an injurious cutting action ensues on the wearing surfaces; it also carbonises the tallow used for lubrication, and burns the gland packings. It now also seems that overheated steam loses a certain amount of its expansive quality, and by its use a less perfect vacuum is obtained, although there is a certain temperature to which it may be brought that the vacuum produced by it will be more perfect than that obtained from saturated steam. So that it seems all the advantages to be gained from superheating may be obtained by simply drying the steam so much as to convert all the watery particles and bubbles held in suspension into dry steam. And in order to accomplish this the complicated arrangements of pipes and winding flues in the uptakes may be considered altogether unnecessary, for not only are they expensive in first cost, and difficult in after repair, hut their presence in the uptakes often acts injuriously in vitiating the draft. The author proceeded to say that the best and simplest form of superheater for marine boilers he was acquainted with consists simply of steam drums encircling the uptakes, these drums being united to each other as well as to the steam space of the boiler by copper pipes, the steam pipe to the engines being taken from the higbest point of one of the superheating drums. Boilers such as these bave been adopted for screw engines of 275 nominal horse-power, which indicate from 1,000 to 1,100 actual. The total grate surface of tbese boilers is 227sq. ft.; the total heating surface, 3,934sq. ft., the superheating surface, 553sq. ft.; and capacity of superheaters, 575cu. ft.; the team space having a capacity of 720cu. ft. The capacity of the latter is, however, of little importance when superheaters of this description are adopted. The arrangements and proportions of these boilers have, in practice, given highly satisfactory results.

The author then introduced tbe subject of high pressure steam worked expansively, and stated that the economy resulting from the use of high pressure steam, setting aside expansion altogether, is measured by the fact of about half a ton of coals being saved in twenty-four hours per 100 horse power actual, by using 100 lbs. steam instead of 40 lbs.; and of course when steam of bigh pressure is judiciously economised by expansion, the advantages accruing from its use are greatly multiplied. This is now, however, so well known and understood, that it would be useless to dilate at any length on the subject further than to state what may he considered the best metbods employed for taking advantage of this valuable property in steam, giving the following as a simple illustration of the great quantity of steam economised by expansion, viz., take for example a cylinder into which steam is admitted of 48 lbs. pressure during a quarter of its stroke, it will be found (seeing that as the volume increases the pressure decreases) tbat the mean pressure behind the piston at half, three-quarters, aud end of stroke are 24 lbs., 16 lbs., and 12 lbs. respectively, thus giving a mean pressure over the whole of 25 lbs. per square inch, which represents a pressure of 52 per cent. of the initial pressure, hut seeing that the quantity of steam used was only 25 per cent. of the whole stroke, the gain resulting from this amount of expansion, viz., 48 lbs. steam, cut off at a quarter is therefore 27 per ceut.

We find the use of fixed stoppers on tbe crank shaft for driving the eccentrics, and thus working the valves, rapidly giving place to other arrangements, as by that method only the expansion given by the setting of the valves can be effected, and as it is almost an absolute necessity to urge the engines to their fullest power under certain emergencies, it therefore follows that the adoption of this certainly simple reversing gear sacrifices the power of working at a high grade of expansion. It must be borne in mind, however, that various kinds of expansion valves have been applied supplementarily to the main valves, the most worthy of notice being the Cornish double-beat valve, generally wrought by a series of variable cams on the crank or intermediate shaft. The arrangement of valve gear now mostly adopted, in preference to the foregoing arrangement, is some modification of Stephenson's original and elegant link motion, which, besides being well adapted for reversing the engines may also be, with tolerable efficiency, employed as a means for obtaining with great ease a variable amount of expansion within certain limits. It is limited, however, in this respect by the injurious amount of cushioning that takes place on the eduction side of the piston when the engine is being wrought at a high rate of expansion, an amount which at certain grades would annul the benefit that would be otherwise attained. The lead of the valve is also

lost at a high grade, unless an injurious amount of lead is given when the engine is in full gear, which of course it is not wise to give.

The disadvantages attendant on the link motion used for expansion has induced the adoption of various kinds of supplementary expansion gears. The author then proceeded briefly to describe a few of the best arrangements of this kind, stating that cut-off plate valves on the back of the main slides have been, and are, used with great advantage, although at the expense of increased complication. These valves are generally worked by means of a single eccentric, attached by its rod to one end of a quadrant, to the other end of which the suspension rod is attached, the valve rod being worked by the quadrant which slides through the guide block attached to the end of the spindle. The raising or lowering of the suspension rod, by bringing the centre of the eccentric rod more or less in a line with the valve spindle, increases or decreases the travel of the valve as required, and by this means a greater or less amount of expansion is obtained at pleasure, without interfering with the action of the main valve. He had seen the plate expansion valve worked thus: a disc is keyed on the crank shaft alongside the expansion eccentric, and to which it is held fast by means of a pinching pin; a slot in the eccentric pulley concentric with the periphery of the shaft allows the eccentric to be shifted to any position in relation to the crank within the required limits, thus giving any required point of cut-off at pleasure, the eccentric pulley may be graduated so as to make the amount of expansion a known definite quantity. This arrangement of expansion dispenses with the complication of the last described arrangement, with the disadvantage, however, of having to stop the engines for the purpose of altering the expansion; a disadvantage that makes this gear better adapted for stationary purposes than marine, unless, indeed, there be a genius amongst us who can invent a simple method of shifting the eccentric without stopping the engines. The author next referred to an arrangement (which was illustrated), of a set of valves applied to a pair of 45in. cylinder stationary engines, and perfectly applicable to marine engines. The indicator diagrams taken from these engines also demonstrated the cleanness of the cut-off and the regularity of the expansive curve. These valves give the required expansion by bringing towards, or separating from each other, the plate valves that work on the back of the main valves. This may be done while the engine is working by turning the brass tube through which the spindles proper pass; on that tube there is cut a right and also a left hand square threaded screw, which, working in the nuts fastened in the bosses on the back of the expansion valves, has the effect of altering the position of the valves as described. Originally it was intended to turn the tubes, and so alter the cut-off, by means of hand wheels keyed on to their ends, which pass through back stuffing boxes, as would be done in single engines. But the difficulty of knowing at what rate one engine might be expanding compared with the other, without the trouble of taking diagrams, presented itself. That difficulty was overcome, however, by a simple arrangement designed by the author, and which arrangement was adopted in this case, and has, in working, given complete satisfaction. It consists simply of a spur wheel keyed on the end of each tube where the hand wheels would otherwise have been. These spur wheels being attached to the valve spindles, had, of course, a travel equal to that of the expansion valves, namely, 9in., and they both gear with a spur pinion on a stud fixed between them. The pinion has a length equal to the travel of the wheels, together with their thickness, so that they are both in gear with it at all parts of their stroke. A hand wheel for the purpose of turning the pinion is keyed on a boss cast on its end. It will thus be seen that, by turning the hand wheel, the expansion valves of each engine will be shifted an equal amount, and in the same direction, thus giving a variable expansion of an equal grade in both cylinders. To make this expansion gear all that could be desired would be to arrange that it should be worked by the rise and fall of the governor balls, thus regulating the speed of the engine by more or less expansion, instead of by the wasteful plan of throttling the steam. This arrangement has yet to be designed however; perhaps a modification of the water wheel governor may be advantageously employed for this purpose. The author thought that in all cases where cut-off slides are used in marine engines, no arrangement for working them is yet applied that would prove so well adapted as that just described, but was of opinion, however, that if the Cornish double beat or equilibrium valve got a fair trial with marine engines, it would of all valves prove the best; and he referred to its adoption not only as a supplementary expansion valve, but proposed it altogether as a substitute for the slide, using one valve for admission and another for eduction; the rapid opening and closing the large amount of area obtained by a short lift, the ease by which a variable expansion can be obtained by means of a tapered cam; and, lastly, the little or no power required to work them, give this description of valve advantages that no other yet invented possesses, either in number or degree.

The author stated that in the three modes of working the plate expansion valves as described, he would draw attention to the various means by which a variable amount of expansion may be obtained by them. In the first arrangement by altering the travel of the valves; in the second, by shifting the position of the eccentric in relation to the crank and in the third, by a greater or less separation of the valves. This is a peculiarity worthy of notice, and one which ought to be remembered. The great and growing importance of expansion had induced him to treat the subject of valves and their gear at greater length than the title of his paper would otherwise have justified him in doing. He could not pass from this subject without referring to an admirable expansion gear, the invention of Mr. John Elder, of the firm of Messrs. Randolph, Elder and Co., of Glasgow, the more especially as it possesses a beauty in its mathematical adjustments that he had not seen equalled in any other expansion arrangement, and which, with the aid of the drawings, he fully described. All the expansion gears described in this paper, or at all events some modification of them, have been adopted for marine engines with more or less success. It has now been generally found, however, that unless an expansion gear be so fitted as to be placed beyond the control of the engineer in charge in the ordinary handling of his engines, it will never receive fair play, and is rendered, to a great extent, non-effective from the fact that engineers at sea almost invariably prefer working their engines in full gear, and throttle the steam for the purpose of speeding the engines, rather than work at any higher grade of expansion. It may be partly on account of this that double cylinder engines have not only held the ground they have obtained, but are likely to gain ground; for it is certain that they, of all other engines, have proved themselves as yet, when properly constructed and proportioned to be the most economical, and of all expansive engines they possess the most regular motion, the low pressure steam in the large cylinder balancing the high pressure steam in the small cylinder. The double cylinder arrangement of engine is the favourite form adopted by Messrs. Randolph, Elder and Co., and with whose name this type of engine is so intimately associated. The best proof that can be advanced of the efficiency and economy of this system is the exclusive adoption of it by several very extensive steam navigation companies, first amongst which may be mentioned the Pacific Royal Mail Company, with whom continued and regular economy in working is of much greater moment than the comparative item of first cost, and that, in this latter respect of economy, these engines have not disappointed, is best shown by the continual and increased demand for them. In fact, the success attending the introduction of these engines was so great, that upon the attention of our Government being forcibly drawn to the subject, they were induced to take the matter up and give the system a fair competitive trial, a circumstance much to be wondered at considering the apathy generally displayed by the Admiralty towards improvements not emanating from themselves.

Accordingly, with a view to compare the double cylinder engines of Messrs. Randolph, Elder, and Co., with those of the favourite makers for the Government, viz., Penn, and Maudslay and Field, the Admiralty placed at the disposal of these two firms, as well as to Messrs. Randolph, Elder, and

Co., one frigate each, namely, the *Arethusa* (Penn), the *Octavia* (Maudslay), and the *Constance* (Messrs. Randolph, Elder, and Co.), each to be engined with a power of 500 horse nominal, and as the frigates were all built to the same lines, and were, in fact, as nearly as possible alike in every respect, it might safely be inferred that the engines that propelled its ship under similar circumstances with the greatest speed, or the greatest distance with the least fuel, were best entitled to the £2,000 premium offered; but, as an illustration of the unaccountable apathy of the British Government in regard to these matters, it may be stated that the ships after being finished, and in every respect ready for sea, were allowed to lay by for a period of nearly three years without undergoing the promised competitive trials, and this, although we may say the whole of the marine engineering world, at least, was eagerly waiting the results of these trials. The trials at last came off only, however, during the summer of 1865, and having waited so long it might be considered but right and natural we should be furnished with satisfactory particulars. Not so, however, for only briefly tabulated statistics were given, and which, moreover, were stated to be merely approximate. It was gratifying, however, to the makers of the *Constance*, and adding another laurel to the fame of the Clyde, to find that, even in the short experimental runs made, she proved herself not only the fastest ship, but she obtained that speed with a less consumption of fuel than the others required for an inferior speed. And as the superiority in economy of the double cylinder engines have always shown to best advantage in long voyages, it may be premised that in the experimental trip to Maderia, the engines of the *Constance* would show a still more decided superiority over those of her sister ships. If the Admiralty officials be not a little more communicative, however, it is just possible that we will not be readily put in the way of drawing a comparison between the merits of the different engines. Seeing the great good that would naturally be expected to accrue to the engineer who produced the engines that gave the best results in these important experiments (the premium of £2,000 was but a nominal prize compared to what might have been expected to follow), it was natural, under these circumstances, that the different candidates for so high a stake would put forth their best efforts to come in the winner. And as of course these efforts would be put forth in the direction of adopting what each competitor considered the best form of marine engine, it therefore appeared to the author that it would be best satisfying the object of this paper to describe shortly the arrangement of engines that three of the most eminent marine engineering firms each considered likely to give the best results; but he here interpolated by remarking that since he had prepared the preceding portion of this paper intelligence had been received that the three competing frigates had arrived out at Maderia, and that the success anticipated for the *Constance* had been more than realised. The ships all left Plymouth at the same moment, each coaled to the same amount, the only difference in other respects being that the *Constance* is stated to have had stores on board for twelve months, while the others had only stores for six months, a circumstance which, if it acted in any direction, certainly militated against the *Constance*. After the start she and the *Arethusa* steamed neck and neck for three days, the *Octavia* being nowhere. A gale, however, separated them, and they never sighted each other. In due time the *Constance* steamed into Maderia. On the third day after her arrival the *Octavia* made her appearance under canvas, coals all consumed, and the *Arethusa* did not arrive until the fifth day after the *Constance*, also under canvas, coals being all done. It now turns out that while the *Constance* consumed about 45 tons per day, the other boats were burning from 65 to 90 tons in the same time.

The author thought the superior economy of the double cylinder engine is by these extraordinary results, now placed beyond question, and the least that can be said about it is that Randolph, Elder, and Co. are well entitled to the prize they have so strenuously endeavoured to win, and have moreover, so gallantly won.

The subject of double cylinder engines in general, and the Randolph and Elder system and their numerous ingenious contrivances, have been so often and so fully explained, illustrated, and described in THE ARTIZAN (and until very recently that journal was the only one that noticed the subject at all) that it is unnecessary to do more than refer to some of the numbers of the journal in which the subject has been treated of and illustrated, viz.:—

Engines of the *Lima*, *Bogota*, and *Callao*: No. 201, Oct. 1859. Engines and reversing donkey of the *Bogota* and the *Lima*, in No. 208, May, page 117, and No. 209, June, 1860, page 145, illustrated by full Plate 165. Engines of the *Lima*, in No. 212, August, 1860, page 217, illustrated by large folding Plate 175.

Engines of the *Valparaiso*, No. 206, March, 1860, page 61, and large size Plate 160. Description of boilers and reversing gear (Plate 160), in No. 207, April, 1860, page 89. Diagrams from ditto, and *Callao*, in No. 213, Sept., 1860, page 252, and Plate 178.

Boilers of the *Guayaquil* and the *San Carlos*, in No. 218, Plates 184 and 187.

MISCELLANEOUS.—Mr. Elder's paper on double cylinder expansion engines, January, 1859, page 10. Notice on performance of *Lima*, June, 1859, page 141. The cylindrical steam boiler, by Mr. Jno. Elder, July 16, 1860, page 205, and August 1, 1860, page 217, and Plate 174.

The author concluded by stating that he trusted to have the opportunity afforded him of completing his paper at the following meeting.

STEAMSHIP PERFORMANCE.

"SALAMIS" AND "HELICON."

(*Continued from page* 6.)

We will next proceed to determine the criterion numbers in regard to displacements, speeds, and powers of the *Salamis* and *Helicon*, in order to ascertain their relative efficiencies, by means of the following formula:—

Let C = the criterion number.
P = indicated horse-power of engines.
D = displacement.
S = speed.

then,

$$C = \frac{S^3 \sqrt[3]{D^2}}{P}$$

Which for the *Salamis*

$$= \frac{2565{\cdot}2 \times 96{\cdot}37}{1388{\cdot}24} = 178{\cdot}1$$

The displacement of the *Salamis* being 946 tons, that of the *Helicon* is 945 tons, hence its criterion number will be,

$$C = \frac{3048 \times 96{\cdot}30}{1610{\cdot}06} = 182{\cdot}31$$

Thus, we observe the *Helicon* possesses a slight superiority over the *Salamis*, in the ratio of 182·31 to 178·1.

In conclusion, it appears that in point of efficiency there is no great difference between the *Salamis* and *Helicon*; both vessels fall short of the theoretical performance at high speeds, as shown in the following table:—

Name of ship.	Calculated speed.	Attained speed.
Salamis..................	14·823 knots.	13·689 knots.
Helicon..................	15·268 knots.	14·500 knots.

The full speeds being calculated from the speeds at half full power, the losses are at full speed.

In the case of the *Salamis*—

= 7·3 per cent.

of the calculated speed.

And in the case of the *Helicon*—

= 5 per cent.

of the calculated speed.

Showing an advantage gained by the *Helicon*.

ON WORK AND VIS-VIVA.

By De Volson Wood.

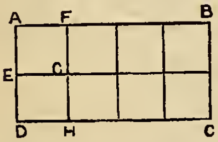
(From the Journal of the Franklin Institute.)

If I make any reply to the last article of Mr. Nystrom upon the subject under discussion, it must necessarily be upon some of the important points which I have previously omitted to discuss. I have no desire to mention them, for their principles are entirely foreign to our subject, and they are so elementary that it seems as if we ought not to be obliged to condescend to their discussion when treating of mechanical problems; but as I do not wish to be considered "unkind" on account of a partial treatment of the question, I will now notice them.

I have noticed several times that his views of multiplication are very different from mine, and it will be evident to the reader that one of us holds to views extremely faulty. For instance, he says, page 57, "When a quantity is multiplied by another quantity, the product becomes a third quantity, different from the two first." And again, "If two square feet be multiplied by a thickness of three linear feet, the product will be six cubic feet."

Now, I hold that, according to true logic, it is impossible to multiply one concrete number by another concrete number, and that every arithmetical process may be clearly analysed without involving any such hypothesis. "But," says the objector, "do you not multiply linear feet by linear feet to make square feet?" I say no, and proceed to analyse as follows:

To find the number of square feet in the rectangle A B C D, I have simply to find how many times it contains one square foot. We may form our unit by taking one foot from D on each of the lines A D and D C, and completing the square D E G H. Now if A D is two linear feet, then will the rectangle A D H F contain two times one square foot, or two square feet. (Observe that it is two times, not two feet times.) Then if A B contains four linear feet, the rectangle A C will contain four times two square feet, or eight square feet. This is the logic, and nowhere have we multiplied linear feet by linear feet. So to get cubical contents, we commence with our cubical unit, which is one cubical foot or inch, as the case may be, and determine each time the abstract multiplier from the linear measure. This process is so evident that I need not dwell upon it. Admit that multiplication can be performed by addition, and we must admit that the true multiplier is an abstract number, and the product is of the same kind as the multiplicand. Hence if power is correctly represented by a plane surface, and time by a straight line, and work by a volume, it appears that work is not the product of power by time; for if we multiply an area (power) by any number (the number of units in the time), we get an area for the result. But if power be correctly represented by a unit of volume, then a repetition of it will give another volume, or work.



Now, I do not object to the illustrations which he has made, if they are simply used to represent the things to the eye; but if they are made the basis of a logical argument, it should be shown that they have the same relation to each other as the things which they represent. Popularly speaking, the illustration is good, because we say in common language that length by breadth gives area, and area by thickness gives volume; but such is not the teaching of true science—of true logic.

So I do not wish Mr. Nystrom to infer, as he seems to on page 57, that when T = 1, time disappears from the formula. I do not wish it to. I cannot tell whether he wishes it to or not, for on page 326, vol. xlviii., he says at least twice in his own definition, that the unit of time is involved. It is implied on page 359 of the same volume. It is admitted on page 183, vol. xlix., when he says the English unit for power is 33,000 pounds raised one foot per minute; and in the three heterogeneous definitions which immediately follow the above, it may be inferred or denied at pleasure, while in his last article, page 57, he says, "Power = F V × 1, the abstract number." If, as Mr. Nystrom says, the products of two quantities become a third quantity different from the two first, will he give us a rule which will enable us to determine the nature or kind of this third quantity? If so, perhaps he can tell what the product will be of five cubic feet by three square feet; of ten hogs by five bushels of corn; of fifteen green pumpkins by ten ripe squashes.

CUT-OFFS.

[From the Journal of the Franklin Institute.]

The controversy between the navy department and the builders of the *Algonquin*, enlivened by the trenchant letters of the constructor of her engines, has forced on public attention the subject of expansion by cut-offs. The sympathies of many practical men are with the builders. They endorse their confidence in the superior qualities of the engines, and their defiance of official opponents. Still, the principles of physics, on which the result depends, are inexorable and insensible to moral suasion or censure. There are those who think the mighty agent, upon which progress depends more than on anything else, has passed through every form and phase of trial, and that its value as a motor is exhausted in modern engines; others, with more reason, believe that, so far from our knowledge of it being complete, much of importance is yet to be acquired. Unacquainted with the parties contending and their experiments, without a shadow of interest in cut-offs, or the slightest prejudice in favour of or against them, I think it has happened to them as to other devices, to which credence has been given without due examination, and opinions taken up on trust. At the risk of having the remark applied to myself, I think they are imperfectly understood. The following thoughts are thrown out with the sole view of aiding in the discovery of the truth.

To economise steam by expansion has been a desideratum for well-nigh a century, and nothing conclusive has been attained. Conflicting opinions are still rife, and the government has charged a commission of experts to solve the problem by a fresh set of experiments. I have no faith in doubtful or hazy explanations of mechanical matters, nor is there any reason why any one should. Whatever is uncertain vanishes when thoroughly looked into, and every man of ordinary talent and persistance can do that. Such is the case with steam.

Although the leading element in the civilisation of our orb, and one in all probability never to be superseded, the properties of aqueous vapour are as palpable and plastic as those of other bodies. As complete control of it may be had as of them. It is weighed in the same scales and its quantities ascertained by the same vessels of capacity as liquids and solids. A pound of it is a pound of water vaporised. The mode of using the measures is somewhat different than with liquids, but not less rigid and correct. One holding a cubic foot of water has to be emptied and filled afresh until the required number is made up, whereas with steam several feet are commonly contained in the space of one, the number being indicated by the pressure. Hence pressure and quantity are complements and explicatives of each other. As volume increases pressure diminishes, and *vice versâ*, the quantity remaining the same. The smaller volume may contain the larger: 5 cubic feet, whose pressure is 40lb. on the inch, contain 10ft. of 20lb., or 20ft. of 10lb., all three being equivalents in cost, quantity, and power. The knowledge of this is essential to a correct appreciation of cut-offs, since as much, or even more, steam may be let into a part of a cylinder than would suffice for the whole.

It will be understood that I here speak of natural steam, not of that doctored by heat and more or less decomposed after actually or virtually leaving the boiler—steam, of which every cubic foot contains, in round numbers, a cubic inch of water, and in the using of which nothing is left in doubt—nothing to mystify or perplex—steam whose power is increased by increasing its quantity, just as more heat is obtained by consuming more fuel, more light by turning on more gas, more wind power by enlarging sails to catch more of it, as the force of a gun is increased by adding powder to the charge, and that of men and animals by increasing their numbers. To double the power of steam the fluid must be doubled. Such we take to be the only reliable theory of forces, whether the motive agent be an elastic fluid, a liquid, a solid, or a living body. Yet vast amounts of time, talent, and money have been and still are being spent to prove steam an exception. Superheating it may, in certain cases, be found useful to prevent premature condensation, but that its value as a prime mover is thereby increased has yet to be established. It adds nothing to the substance of the fluid. Another query is, whether any alleged gain does not cost, all things considered, as much or more than it is worth.

If a sluice-gate be arranged to deliver more water on one part than on another of an overshot wheel, no more power could be got from it than from the uniform discharge of the same quantity upon it. The power would be in the weight of the liquid, and that would be the same in both cases. So with steam: it is the quantity let into the cylinder that determines the power, not the mode of letting it in. This is, however, questioned. Advocates of cut-offs insist that when the whole force or charge is opened on the piston in the first part of the stroke and left to expand and follow it to the end, a better effect is obtained than from an equal, or even greater, charge let in regularly from the beginning to the end, or near the end of the stroke.

It has been thus accounted for:—"By the momentum given to the matter which the engine is moving—it may be the fly-wheel, or the steam boat itself, or the train of cars, all of which when once set in motion will not suddenly stop, even though all power were suddenly suspended from driving them, and which therefore will continue to go on under the diminished pressure of the expanded steam. Thus you see that when the steam is cut off from the cylinder, that which is in it continues to push on the piston with diminished force, but still with some force; and as the piston cannot stop, it absorbs, and through the wheels which it drives gives out again to useful effect whatever pressure is thus spent upon it, just as your watch will run all day, although the spring which drives it grows weaker and weaker as it is relaxed.

"The gain which can be obtained from the use of expansion is measured by the extent to which you carry it; or, in other words, how short you cut off the steam in the cylinder.

"Ten expansions will do three times and a third as much work as no expansion, using the same amount of fire and steam."

Progressive movements dependent on varying momenta abound in every department of nature. Animals that go forward by springs or leaps are examples. The path of some birds through the air is a succession of ascents and descents—a series of undulations or curves—rising by the action of their wings and descending without it. The principle of thus applying force is therefore a sound one, and the question is its adaptation to artificial machinery and propulsion. We find it confined by the Great Engineer to organisms specially fitted for alternations of leaps and stops, and whose functions are incompatible with uniform speed. Neither the locomotive organs of natural machines, nor the conditions under which they act, are applicable to ours, nor ours to them. There is not a rotary propeller in nature, while we have in the wheel the most equable and perfect instrument of progression. Its supreme excellence is its complete adaptation for receiving and transmitting continuous motion without jarring the masses it moves, and consequently without a varying momentum. With cut-offs there is of necessity an inequality of pressure on the pistons, and therefore an inequality of motion in bodies impelled by them—an effect fatal to stability and durability.

If the second proposition in the quotation is to be received, the laws of force and resistance would seem to be at fault.

The next dictum is specific and not to be misunderstood. Could it be proved, a chief niche in the world's Walhalla would be due to its author. That by the same quantity of steam more than three times the work can be performed with a cut-off than without one is incredible, and if true a miracle almost as great as

making three gallons of water out of one. If the resistance were greatest at the beginning of the stroke, and fell down to zero at the end of it, there might be cause for some gain, but, so far from that, it may be considered uniform in bodies moved by steam, whether ploughs, ships, cars, or manufacturing mechanisms. Whatever may be said to the contrary, we must continue to believe, till controverted by facts, that there can be no saving of steam power by substituting a succession of impulses for continuous pressure, except in cases where the resistance rises and falls with the piston's movements. Whether there are such cases we know not, but it is certain that sudden changes of force and velocity are not the things for steam machinery, no more than are springs and leaps (sensible or insensible) for bodies moved by it.

The popular idea is illusive. It is the impression of many that when the cut-off acts at half-stroke, half is saved; at one-third, two-thirds; and at one-fourth, three fourths. They forget that pressure indicates quantity. Engines with cut-offs of necessity use steam of greater tension than others, and the less the charge the greater the tension. The only difference is that one class uses small volumes of high pressure, and the other large volumes of lower pressure, the requisite quantity being the same in both. An engine is worked with steam of 100lbs. on the inch, and cuts off at half-stroke. The mean pressure of the latter half is, therefore, 75lb., and that of the whole stroke 87lb. on the inch. Observe that twice the force is expended on the first half than suffices for the latter half, and (the resistance being the same) twice the amount required. Where then is the difference in the amount consumed between charging the cylinder with 87lb. steam, and with it varying from 100lb. to 50lb.? In every case as much of the fluid must be admitted as will push the piston to the end of the stroke, whether sooner or later cut off. Another engine has a cylinder of the capacity of 12 cubic feet, and requires steam of not less than 12lb. per inch pressure. This does the work without a cut-off. Suppose it be determined to apply one and cut off at half-stroke, would not the tension have to be raised to 24lb. on the inch, if cut off at one-third to 36lb., and if at one-fourth to 48lb.? In fine, does it not follow that theoretically there is no more to be gained by cutting off at a quarter than at half-stroke, and no more by that (unless in special cases alluded to) than with no cut-off at all? To determine how far practice conforms to theory there is a conclusive experiment—apply the same quantity of steam used with a cut-off to the same cylinder without one.

ON THE DETAILS OF WATERWORKS.

(Continued from p. 269, vol. iii.)

There having been a very considerable difference of opinion as to the item friction, it is well to reduce this element as much as possible by eliminating all such quantities as may be ascertained; hence, although in the instance selected for examination we may not be able to deduct the values of any other causes of loss of power, yet it may be desirable in this place to show by what method it may in some cases be done.

The power absorbed by the main pump valves in opening is usually included in the total friction, but it in some instances admits of calculation; wherefore it is desirable to give some account of the different forms of valves commonly in use, and their effects upon the working of the engine.

The old butterfly valve was soon found to be quite inapplicable to large pumps on account of the enormous concussion created by them in closing, the reason of which is as follows:—The lower or suction valve in falling does not produce a blow due only to its own weight, but one due to the combined effect of its own weight and the pressure upon it caused by the column of water resting on it and the preponderating weight, for the butterfly valve exposes so large a surface (in proportion to its weight) to the resistance of the water in the valve chamber that it will not readily pass *through* the water; hence, except the pump were stopped at each end of its stroke for some much longer time than would be practicable, such valves must fall *with* the column of water and preponderating weight, and thus inflict a very heavy blow upon the valve seating, as well as allowing a considerable proportion of the water raised into the pump barrel to escape back into the well through the wind bore. In some instances the loss of water through the inefficiency of these valves has amounted to as much as 14 per cent. of the total quantity raised. The upper or discharge valve produces a similarly severe blow due to its own weight and the pressure upon it from the standpipe or air-vessel.

In order to give some idea of the amount of work thus expended on the valve and its fittings, let us calculate it for an upper valve assumed to be 20in. diameter, divided into two semicircular flaps, the extreme opening of each flap being six inches, and the level of the water in the stand-standpipe being 100ft. above the valve, then the pressure of the water will be—

$$= 0{\cdot}434 \times 100 = 43{\cdot}4\text{lb. per sq. in.}$$

the area of each flap will be—

$$= \frac{\overline{20}^2}{2} \times 0{\cdot}7854 = 157 \text{ sq. in.}$$

hence the total pressure exerted by the water on each flap will be—

$$= 43{\cdot}4 \times 157 = 6813{\cdot}8\text{lb.}$$

assuming the valve flap to weigh about 300lb., the total weight in action on each flap would be—

$$= 6813{\cdot}8 \times 300 = 7113{\cdot}8\text{lb.}$$

The work done by the descent of this weight will be equal to its intensity (7113·8), multiplied by its mean distance of descent in feet, which is the distance of descent of the centre of gravity of the semicircular flap. The centre of gravity of a semicircle is nearly 0·425 of the radius distant from the diameter bounding the semicircle; hence, in the present case, the spaces passed through by each part of the flap being proportional to its distance from that diameter, and the extreme space being assumed, as above, at half a foot, the work done on each flap will be,—

$$= 7113{\cdot}8 \times 0{\cdot}5 \times \frac{10 \times 0{\cdot}425}{10} = 1511{\cdot}68 \text{ ft. lb.}$$

and the total work expended on the valve seating due to the action of the two flaps would be—

$$1511{\cdot}68 \times 2 = 3023{\cdot}36 \text{ ft. lb.}$$

every time the valve closes.

From this it is easy to account for the fact that such valves are impracticable for large engine pumps.

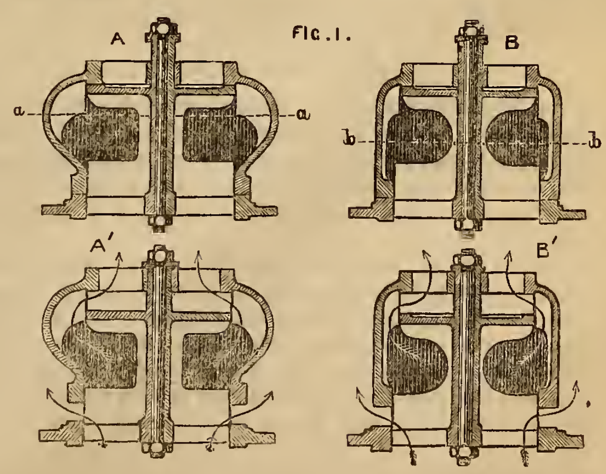
A perfect valve should, when open, allow the most free egress to the water passing through it, and close directly the motion of the water ceases, passing through the water, and absorb a minimum of power. Great improvements have, of late years, been made in the construction of valves, and at present a very great variety of them exist, but we shall here merely describe a few of the most important.

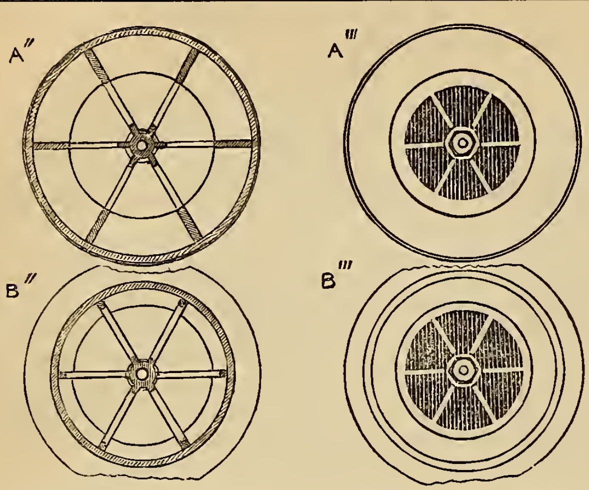
In order that a valve may in closing pass (we use the word *pass* advisedly, as it will be seen hereafter that some valves do not *fall* in closing) through the water rapidly, it is evident that the force tending to close it must be great in proportion to the area of its surface, upon which the water exerts its power of resistance normally to such surface.

Let us first take the case of a falling valve, then the closing power will be its weight. To increase the closing force in proportion to the surface acting upon the water normally, we must evidently either increase the weight of the valve or diminish that surface; if we do the former we also increase the resistance to being opened; hence we must decrease the resisting surface of the valve, and this must be done without diminishing the area of waterway through it.

This is effected in Harvey and West's valves, two forms of which are shown in Fig. 1.

FIG. 1.





The valve shown at A A′ A″ A‴ is an improved form, the supposed advantages of which will subsequently be explained; the original form is shown at B B′ B″ B‴.

A B are vertical sections of the two forms of valves shown closed; A′ B′ are the same shown open, the direction in which the water passes through them being indicated by the sinuous arrows; A″ B″ are horizontal sections of the valves taken on the lines *a…a*, *b…b* respectively; A‴ B‴ are plans of the valves.

An inspection of the illustrations above described shows that these valves have two seats or beats, wherefore they are termed "double beat valves," and by this formation the area of the resisting surface is reduced without reducing the waterway or materially increasing the weight of the valves. At the bottom seat there is the same area of waterway as in an ordinary flat spindle valve, and there is also, in addition to this, the waterway afforded over the upper seat, while the area of the resisting surface is equal to the difference of areas of the upper and lower beats.

It is necessary to be particular as to the measurements of these areas, for the calculations relating to the suction and discharge valves. The diameters should be measured thus: take the *inside* diameter of the *lower* seat, and the *outside* diameter of the *upper* seat to determine the area upon which the water acts in *opening* the valve.

If we assume the interior diameter of the lower seat to be 10in., the exterior diameter of the upper seat being 9in., then the difference of areas will be—

$$95{\cdot}033 - 63{\cdot}617 = 31{\cdot}416 \text{ sq. in.}$$

which will represent the area upon which the water must act in opening the valve.

A valve of such dimensions would weigh about 100lbs., hence the pressure requisite to open the suction valve would be—

$$\frac{100}{31{\cdot}416} = 3\text{lbs. per sq. in.}$$

In this calculation we have not made allowance for the reduction of pressure requisite to open the value due to the fact of its immersion in water; this reduction would amount to about one-seventh of the weight. In the case of the upper valve there is, of course, the weight of the column of water upon the valve to be overcome in opening it in addition to its own weight.

The column of water thus acting upon the discharge valve is annular, having a base bounded by two circles, of which the smaller is equal to one of which the diameter is equal to the diameter of the *inner* edge of the *top* beat of the valve, the larger circle having a diameter equal to that of the *outer* edge of the *bottom* beat. When the valve is open, this last element may be regarded as not acting upon it, as it will with the rest of the water be flowing away driven by the stream issuing from the pump.

The amount of work actually done in opening the valve is, of course, equal to its (specific) weight multiplied by the distance through which it is raised.

Taking the weight of each valve as 100lbs. and its height of rise as 2in., which would be about the proper rise for a valve of the dimensions above assumed, we find the amount of work done throughout the stroke for each valve as follows:—

First deducting the weight of an equal bulk of water, we get the specific weight of each valve thus—

$$100 - \frac{100}{7} = 100 - 14{\cdot}28 = 85{\cdot}72\text{lbs.}$$

the rise of the value,

$$= 2 \text{ in.} = \frac{1}{6} \text{ foot.}$$

hence the work done would be—

$$85{\cdot}72 \times \frac{1}{6} = 14{\cdot}286\text{ft. lbs.}$$

for each valve, and for the two valves at each stroke, it would be—

$$14{\cdot}286 \times 2 = 28{\cdot}572\text{ft. lbs.}$$

Let us *assume* the area of the pump plunger to be 1 square foot, its stroke 8ft., and the *average* head of water against which it is working to be 100ft. Then the quantity of water raised at each stroke of the engine will evidently be 8 cubic feet, and as 1 cubic foot of water weighs about 62·5lbs., the weight of water raised by the engine at every stroke should be—

$$= 62{\cdot}5 \times 8 = 500\text{lbs.}$$

and as this load is raised to an average height of 100ft., the amount of work so done will be—

$$= 500 \times 100 = 50{,}000\text{ft. lbs. per stroke.}$$

Let us now determine the relation borne to this quantity by the work absorbed in opening the valves (28·572ft. lbs.)

$$50{,}000 : 28{\cdot}572 :: 100 : 0{\cdot}05714 \text{ per cent.}$$

This is the *work* which appears to be absorbed by the valves; but it is evident that more is lost, because all the time the valve is open, it is kept so by the pressure and friction of the water passing through it; and although it may be chiefly in the form of friction, yet the *work* is lost and does not appear in the useful effect.

Allowing for the reduced weight due to the medium in which the valve is immersed, we find, from calculations given above, that the pressure requisite to sustain the valve is—

$$3 - \frac{3}{7} = 2{\cdot}572\text{lbs. per sq. in.}$$

which *should* represent the difference of pressure above and below either valve, when open, and which must of course act over the whole area of the pump plunger.

The pressure per square inch due to a column of water 100ft. in height is—

$$100 \times 0{\cdot}434 = 43{\cdot}4\text{lbs.}$$

and the percentage of pressure added to this (and therefore lost in friction) will be—

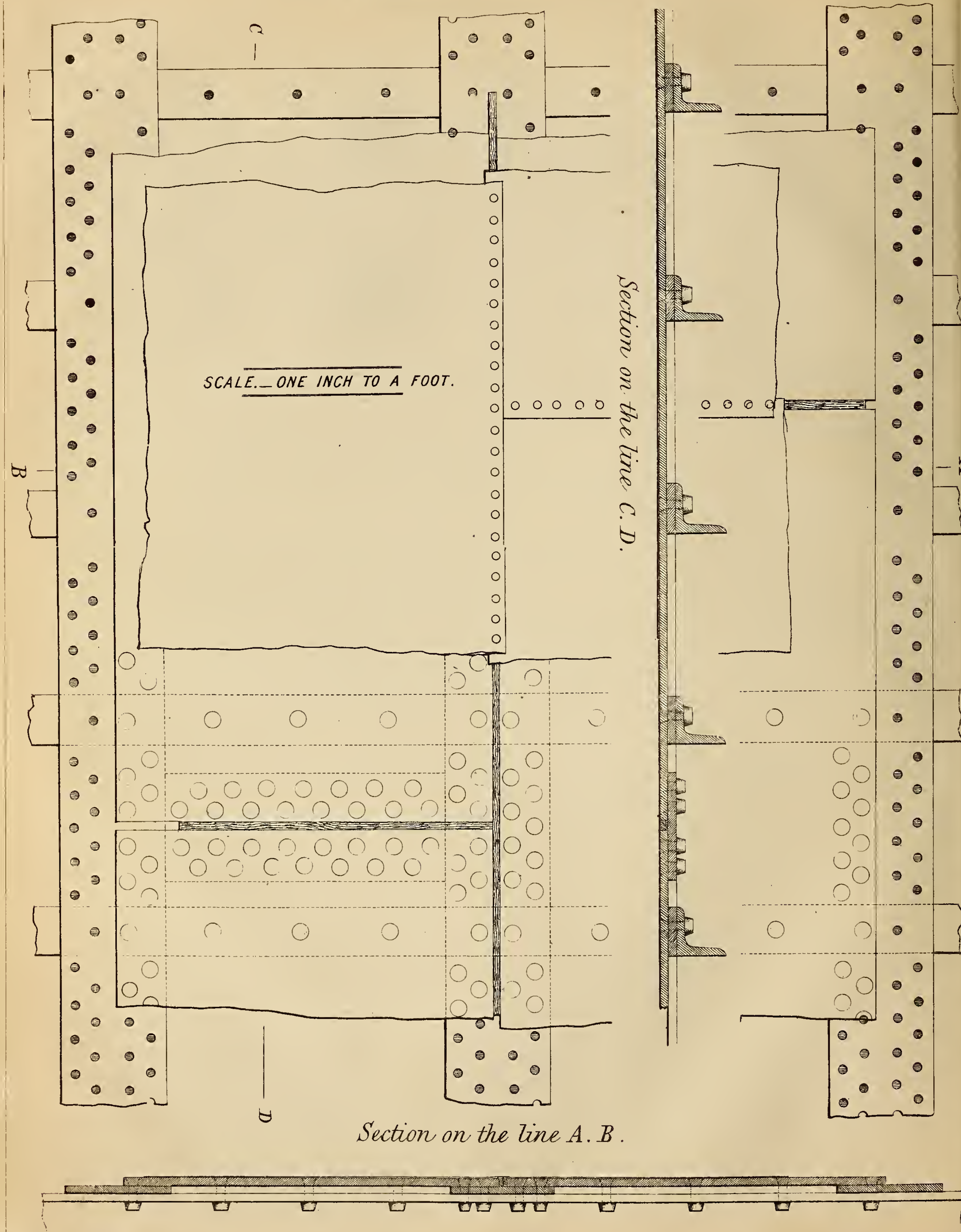
$$43{\cdot}4 : 2{\cdot}572 :: 100 : 5{\cdot}9 \text{ per cent.}$$

or nearly 6 per cent. of the work done by the engine.

In the improved form of Harvey and West's valve (A A′ A″ A‴) great facility is afforded by the shape of the valve for the passage of the water through it, and possibly it is also more elastic than the ordinary form, and therefore produces less concussion in falling.

We will now pass on to describe some other forms of improved valves exhibited in fig. 2: A represents a compound valve derived from the common spindle valve. It is divided into annular pieces, the bottom piece resting on the valve seat, and itself forming a seating for the piece above it, and so on to the top ring, which is closed by a circular flat valve. In this valve the various rings fall successively, as the engine finishes its stroke, so that the final shock is only that due to the small circular piece which closes the aperture in the top ring. This valve is undoubtedly a great improvement upon the old flat valve, but in our opinion it is greatly inferior to Harvey and West's double beat valve.

SHEATHING FOR IRON-SHIPS.



W. Smith C.E. direx

B represents a compound valve, consisting of a number of annular seats, or tiers, raised as shown in the section one above another, and being pierced by a number of apertures capable of being closed by balls or

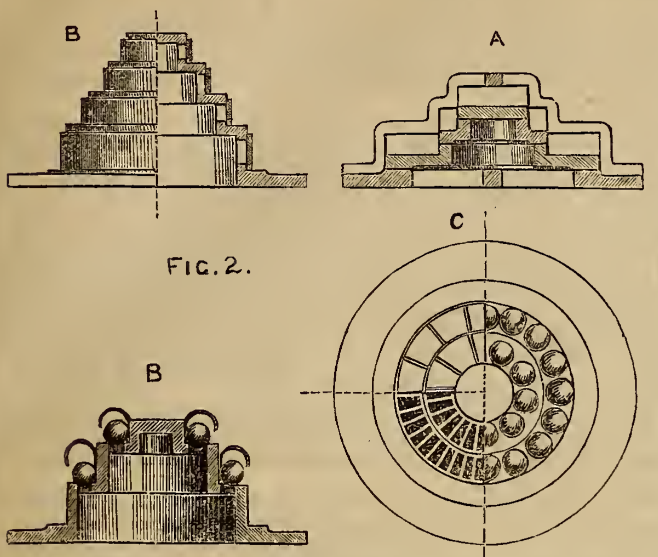


FIG. 2.

spherical valves, above which are fixed guards to prevent their rising too high above their seats. A similar principle is also observed in a valve formed in the same way, but having india-rubber or leather flaps instead of the spherical valves above described. C represents two half plans, one showing the valves in the spherical form, the other exhibiting them as flaps. D shows a view half in section and half in elevation of Mr. Morris's valve, which he has introduced successfully at the Kent Waterworks. It will be observed that the general form of the seatings is the same as in the last instance; but in this case the perforations are in the *vertical* instead of in the *horizontal* surfaces. Round these vertical surfaces are strained india-rubber bands, which act as valves, expanding to allow the water to pass out over their edges, and contracting and closing the valve apertures as soon as the engine completes its stroke.

(*To be continued.*)

THE CONSTRUCTION AND SHEATHING OF IRON SHIPS.

(*Illustrated by Plate* 296.)

At a recent meeting of the Liverpool Polytechnic Society Mr. L. Daft read a paper in which he said as follows. Before the year 1761, when the Admiralty made use of copper sheathing for the first time on their vessels, the means adopted to prevent fouling were very ineffective.

The subject had been studied by scientific men for some ages previously, but it would appear that they were unacquainted with the conditions necessary to success. In illustration of this, I may mention the prevailing idea that barnacles and seaweed could be readily poisoned; and when, in 1765, the copper on H.M.S. *Alarm* was found to be perfectly clean, after a four years' trial, the success was attributed to its poisonous character.

The introduction of iron as a material for shipbuilding caused the question of fouling to be discussed afresh.

Of course it was well known that iron would oxydize, consequently, a steady stream of patents for paints, compositions, &c., set in, and although about three hundred have been obtained during the last thirty years, the fouling of iron ships is still an evil of startling magnitude.

In 1847 the Admiralty, alarmed at the apparently incurable disadvantages attending the use of iron, had actually commenced selling the iron ships then in the service, when the success of a composition, invented by Mr. Hay, the Admiralty chemist, and applied to the *Undine*, induced them to reconsider their decision.

That they were not without some justification for a course which sounds so strangely now, the following facts will show.

The *Grappler*, in less than three years from the date of order for building her, was so corroded, that a hole 5in. in diameter was discovered in her plating while she was at Madeira.

The *Jackal*, which was coated with red lead in May, 1847, was docked in April, 1848; her bottom was not only exceedingly foul with barnacles, &c., but the plates and rivets were found to be corroded to such an extent, that it was considered necessary to remove two hundred defective rivets, and to punch holes and plug them.

From the bottom of the *Antelope*, on her return from the coast of Africa, and after being docked fifteen months, more than 6 tons of barnacles, &c., were removed, the iron was much corroded, and it was necessary to replace many rivets.

The *Harpy*, upon being docked, after four years' service on the S.E. coast of America, was found to have her bottom thickly covered with barnacles, shell fish, and weeds; the iron plates were much oxidised; flakes from 4in. to 6in. in diameter, and ⅜in. to ½in. thick, were removed, together with a number of the rivets.

I will now give one or two instances to show the wretched condition in which our magnificent iron frigates, coated with the most approved anti-fouling compositions, are frequently found at the present day.

In September, 1862, H.M.S. *Resistance* was placed in graving dock at Portsmouth. She was found to be thickly overgrown with weed, some of it 3ft. long, and beneath this barnacles and oysters were clustered in large masses of 6in. to 8in. in diameter, and 18in. to 2ft. apart.

The anti-fouling composition, which had been applied but a few months previously, was rubbed off in several places, and holes were eaten completely through the ship's plating by oxidation. A few days after she was cleaned I visited her, and heard from one of the officers that nearly 20 tons of barnacles and seaweed had been removed from the bottom.

On the 18th November, 1865, it was officially reported that "although the bottom of the new frigate *Achilles* was coated over before her launch with the anti-fouling composition of Mr. Hay, the Admiralty chemist, so foul had she become while lying in Chatham Harbour preparing for sea, that in the run from Chatham to Devenport her speed fell off more than 3 knots per hour from her steaming rate on the occasion of her official trip at the Maplin Sands."

In order to repel barnacles and sea-weed successfully, it is necessary that the surface of the material employed should exfoliate; when such is the case incipient barnacles have no sooner obtained a hold, than they are pulled off together with the surface to which they had attached themselves.

Copper possesses this property in an eminent degree; but experience had shown, before the introduction of iron ships, that when iron and copper are connected in sea water, the iron is rapidly destroyed.

In the early days of coppering wooden ships it was found that the iron bolts beneath the copper sheathing were eaten away in an incredibly short space of time, and composition bolts were substituted.

The destruction of iron is not the only effect produced, for the copper is influenced in like proportion; and if the superficial area of the iron approaches that of the copper, the latter is coated with carbonates of lime and magnesia, and loses all its anti-fouling character.

What we require as a sheathing for iron ships is a metal that is positive to iron, and will therefore preserve iron; which will exfoliate sufficiently to remain perfectly clean in any waters, and at the same time, be capable of wearing four or five years without renewal.

The only metal which fulfils these conditions, when in metallic contact with iron, is zinc.

That zinc fouls on wood, or when isolated, is well known; but the cause of this becomes an advantage when it is applied to iron.

When a wooden ship is sheathed with zinc, the surface of the sheathing soon becomes covered with a peculiarly hard oxide, which acts as a preservative, but exfoliates so slowly and irregularly, that fouling often takes place to a considerable extent.

But when in metallic contact with iron, in sea water, galvanic action causes zinc to exfoliate with the certainty and regularity of copper; and all through an extensive course of experiments, zinc, in contact with iron, has invariably remained perfectly clean, the loss being about the same as with good samples of copper.

Pieces of zinc exposed in the same places, but isolated, were to a certain extent fouled.

In some cases a great loss from oxidation takes place inside the vessel and, with a view to extending the protective nature of the sheathing, it is proposed to unite the exciting fluids (bilge and sea water) by means of an arrangement similar to that used for a like purpose in Daniel's Battery, and which will be understood, by those acquainted with galvanic effects, to bring under control the amount of loss or exfoliation of the zinc, by regulating the extent of the surface of iron exposed, and thus aid or retard the peeling qualities of the zinc, according to the different degrees of fouling which exist in different localities, and at different seasons.

Having now explained the reasons for, and advantages gained by, using zinc sheathing on iron ships, it will be necessary to explain the mode of applying it.

The most common method of plating vessels at the present time is that known as the "in and out" lap, all horizontal joints being lapped, and all vertical joints being butted with a strip behind; in the new system all joints, both horizontal and vertical, are alike being formed in every case by riveting the plates to strips on the inside, and leaving a space between the edges of the plates equal to their thickness.

In this manner a groove is formed round each plate into which dried and compressed teak is driven and pared off flush, thus giving a good foundation for nailing on metallic sheathing.

The zinc nails are used of sufficient length to turn again or clinch by coming in contact with the butt strip, and this, combined with the expansion of the compressed teak by moisture, gives them immense hold.

It is proposed to use zinc about one-twelfth of an inch thick, which is only one-half of the cost of ordinary copper sheathing, and, when nailed round the edges, has sufficient stability to lie close against the iron.

Small holes may be drilled in the centre of the plate and plugged with teak; into these nails can be driven so as to hold the sheathing in exceptional places.

The edges of the plates being left from the shears, and the teak being carefully dried, compressed, and forced tightly in, renders its removal a matter of difficulty directly moisture gets to it: in fact, so perfect is a joint thus formed, that eminent practical men have given it as their opinion that other caulking might be safely dispensed with.

If we look at a section of the ordinary in and out lap, it will be seen that by bringing the alternate inside strakes to a level with the outside strakes we are increasing the displacement while we actually diminish the frictional surface.

And that is precisely what this method of construction does.

With a fair flush surface we have no sharp edges for oxidation to commence from, or if paint be used, for paint to peel off at, and we certainly have a faster vessel; it may not be much, but she must be faster.

By this system there is no necessity for "drifting" rivets, in order to make a decent butt joint.

With regard to strength, it is sometimes objected that in this plan of construction the vertical joints are weaker than the ordinary butts, but it is easy to get from the rivets alone a compressive strength equal to the solid plate, and when we add the horizontal butt strap the strength to resist compression is fully equal to the ordinary joints, while the tensile strength is considerably greater.

In tensile strength, of course, an open butt and a close one are precisely similar.

The same remark applies to the open butts and ordinary laps, the former having an advantage in compression or in case of shearing off rivets, for the edges of the plates would come together before the rivets were cut through.

In the course of the ensuing discussion Mr. Baker said that Mr. Daft's arrangement with respect to butt joints tended slightly to weaken the ship. With respect to a remark which had been made, that close butt joints were only to be seen upon paper, that depended upon the place where the ship was built.

In answer to members, Mr. Daft said eighteen months was the longest period that the experiments upon zinc and iron immersed in water had been in progress; but the metal had not shown the slightest appearance of fouling. It had been in the worst localities, and in the most trying seasons; and from these experiments, the conclusion was that the sheathing would completely protect the ship for five years. The sheathing had been immersed at various places, but not off the coast of Africa; althoug it was to be remarked that ships sheathed with copper had returned from the coast of Africa, perfectly clean, and when submitted to the same test in Chatham Harbour had fouled.

It was perfectly easy to make the ship water tight independently of the teak, by caulking in the ordinary manner before the teak was put in.

In answer to some inquiries, Mr. Daft said, that the zinc sheathing could be calculated at half the cost of copper sheathing. It could not be applied to an ordinary ship, the vessel must be constructed from the keel upwards on this system. No danger need be apprehended from the water getting in between the plates, inasmuch as the zinc protected the iron; that is, the zinc destroyed itself, whilst the iron remained whole.

RAILWAY ACCIDENTS.

We purpose in the following remarks to call our readers' attention to the nature of a class of accidents of which the occurrence has been somewhat common of late on the south side of the metropolis, and which it appears that a proper amount of care would obviate in a great many nstances.

A considerable number of arches have from time to time fallen down on certain lines of railway south of London, connected with the London, Chatham, and Dover Railway, and in almost every case the cause is found to exist in the badness of the foundations. It is but a few days since a bridge near Beckenham, on the London, Chatham, and Dover Railway thus failed, though fortunately it was not under the load of a passenger train, for had it been so the results could not have failed to be of the most appalling character.

It is a well known fact that in most of the southern environs of the metropolis the foundations are not naturally of a favourable description, hence it behoves engineers and contractors engaged in the erection of structures in those localities to be especially careful to find solid ground upon which to build their works, and it is doubtless from their neglect of this point that so many bridge failures have occurred.

It is a very simple matter to determine, by boring, the nature of the soil with which we have to deal: hence if the engineers and contractors are not acquainted with their foundations, it is evidently by reason of their own apathy, and on the other hand if they do know it, but, to save expense, put down their footings before they have reached a sufficient depth to obtain a solid basis, then they are undoubtedly highly culpable, and the more so because it is not only the loss of property which they thus recklessly risk, but also the loss of life.

Insufficient importance has been attached to the making of bad foundations at inquests held in cases where fatalities have resulted from such causes, and that is probably the reason why the same kind of accident is repeated again and again.

Some time back a number of arches fell in at Brixton. They have been renewed, and rings of brickwork have been run up under the intrados to strengthen them, but unless the foundations are sunk deeper than they were before the accident, these rings can be of but little service, for it should be remembered that these arches failed not from weakness of the superstructure, but from the faulty nature of the soil upon which the foundations were laid; hence it is a matter of speculation whether these arches may not come down again some day; and we certainly cannot place much reliance upon the safety of the neighbouring arches, which, it is only reasonable to suppose, rest upon a bottom similar to that which proved itself unequal to the task of sustaining the weight on the foundations of those parts of the viaduct which actually fell down.

The inspection of railways by Government officers is supposed to some extent to guarantee the safety of the lines, and prevent their being opened for general traffic unless they are perfectly secure, but we have had evidence lately that this guarantee is not always certain. There is no doubt that, as far as superstructure is concerned, the works are quite open to inspection; but it is different with foundations. The soundness has to be trusted almost entirely to the engineers and contractors for the line; the officer appointed to examine the works cannot *see* the foundations, so he has to take it for granted they are executed according to the drawings, which, in many instances, may not be the case.

No very obvious means appear to enable this difficulty to be overcome, and travellers may continue to risk their lives through the ignorance, carelessness, or cupidity of those who undertake the execution of public works, unless the directors of railways take measures to entrust their contracts in the hands of those who are both skilful and conscientious, which it is certainly their interest to do, as the more durable the works are the less they will cost for repairs after completion, and the less chance will there be of the company having to pay heavy damages to sufferers from calamities arising from inferior or scamped work.

Government interference during the progress of the works would undoubtedly remedy the evil of which we are speaking, but so large a staff of officials would be requisite to thoroughly overlook all the works in course of construction in the United Kingdom, that such a means of attaining the desired end is practically beyond our reach.

It should be thoroughly understood—and this is a point which we are very anxious to place in a salient position—that in works of an ordinary character there need be no uncertainty about foundations. There may be difficulties; it may be necessary to excavate to a great depth in order to arrive at a solid bottom, but all such facts may be ascertained easily before the work is commenced, and provided for accordingly. Let it not be thought that mistakes as to soil or foundations are excusable on the part of the engineer, for they are not; and considerations of expense must not be allowed to weigh where life is at stake. Faults such as those we refer to scarcely fall heavily enough upon those who are their real authors. If the company whose bridge slips down has to compensate the sufferers or their relatives, that in itself does not particularly affect the engineer, who is in reality the culpable person, for it is not only his duty to design the works in such a manner that they shall fulfil the purpose for which they are projected, but also it devolves upon him to take such means as shall ensure the structures being executed by the contractor in accordance with his designs, or, at all events, not suffered to deviate from them without his concurrence.

AN ACCOUNT OF THE WATER-BAROMETER CONSTRUCTED AND ERECTED BY ALFRED BIRD, EXPERIMENTAL CHEMIST, BIRMINGHAM.

(From the *Philosophical Magazine.*)

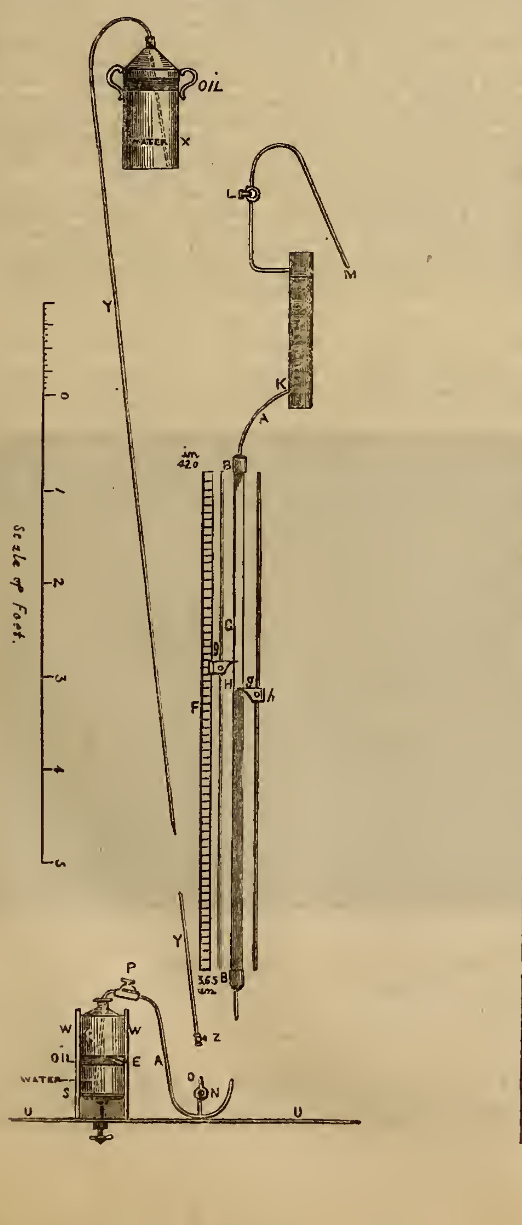
At the last meeting of the British Association held at Birmingham, I had the pleasure to show a water-barometer which has been in perfect action for six years. A general desire having been expressed that some account of the instrument should appear, I have the pleasure to send you the following particulars and drawings.

In the construction of a water-harometer four things have to be attended to :—

1st. The water must he deprived of air.
2nd. The air must not again enter the water.
3rd. The water must go into the barometer, to the exclusion of the air; and
4th. The instrument must be so constructed that, while the atmospheric pressure within the instrument shall be uninterrupted, no air shall penetrate into the vacuum-chamber.

I hegin by describing the material. The tnbe is composed of metal and glass, and the three taps are those which go by the name of "Lambert taps." The size of the metal part is half an inch internal diameter, and is that sort of white metal tnbe which is in universal use by gas-fitters, called "compo." I believe it is an alloy of lead and zinc.

I recommend that which is made by Messrs. Stock Brothers and Co., in Birmingham, as their compo tnbe will stand an internal pressure of fifty pounds of air to the inch without leaking: it is also very cheap. The glass tube to show the "readings" is 1in. internal diameter and 6ft. long. The brass Lambert taps are half an inch internal diameter. These taps are constructed internally with a cnshion of india-rubber, pressed down by means of a hrass plate acted upon by a screw, which makes them absolutely secure.



I now proceed to describe the upper and lower parts of the barometer in refereuce to the accompanying wood cut. A A is the compo tube, having two enlarged sockets B B, $1\frac{1}{2}$in. in diameter and 3in. deep. These sockets were made of brass, and their office is to receive the ends of the glass tube. To fix the glass tube C, about 6in. of the compo tnbe was soldered to the bottom of the socket, and being inverted and fixed very steady, enough dry sand was poured into the compo tube to fill it up to the *bottom* of the socket B. The using of the sand was to prevent the cement from running into and stopping up the compo tube. The glass tube C, perfectly clean inside, was now placed in the socket; and being most carefully steadied to keep it upright, 6in. of dry sand were poured down to keep the cement from rising up the glass tube C.

The cemeut was composed of two parts of gutta-percha and one part of common black pitch. These two snbstances were heated in an iron ladle with a lip, till they became perfectly fluid aud quite free from froth. A "copper bit" used by plumbers having been heated to low soldering heat, a small quantity of the cement was poured into the socket. The copper bit was then applied to the outside, the effect being to perfectly liquefy the cement *in situ*. A little more of the hot cement was then poured in, and again the heated copper bit was applied till the socket was quite full of very fluid cement without any air cavities therein. As the cement cooled, it clung to the glass and metal, and hecame absolutely solid and air-tight. If the cement is poured in all at once, it is impossible to prevent crevices, which will let in air when the barometer is filled, causing the water gradually to descend till it falls out of the instrument.

A place being chosen on the staircase of my house, a flat board, 7ft. long and 1ft. wide, was fastened to the wall, upon which board was fixed the socketed glass tuhe C, and graduated scale F, from the top of which 422in. were most carefully measured down to the "zero"-point E beside the cistern.

The scale F is to the right of the glass tuhe. It is made of well-seasoned boxwood, and is graduated to inches and tenths. The sliding-tuhe G, with the vernier H, is between the glass tube and the boxwood scale F. On the left side of the glass tuhe C is another sliding-tube *g*, with a vernier *h*, to record position of top of tidal colum of water at 9 a.m. the morning previously.

The glass tube, scale, and verniers having been securely placed on the board and perfectly upright, the gas-fitter proceeded to connect, by soldering, the remainder of the compo tube above the glass tuhe C, which was continued upwards till it entered nearly at the bottom into a round vessel K, made of zinc, 4in. in diameter aud 18in. high. Inside the vessel the tube coils round in a spiral, like the worm of a still. This vessel and spiral are not necessary to the action of the barometer; but as the spiral is in the part of the tube in which is the vacuum-chamber, it gives the opportunity of artificially cooling with ice or snow the included aqueous vapour, aud thus determiuing by actual experiment the amount of correctiou required.

If the experiment of cooling the included vapour to 32° he tried in summer, wheu the external temperature is 70° or 80°, the sudden cooling causes so great an evaporation from the surface of the water, and coudensation in the upper part of the barometer, that a real raiu-shower is produced, the condensed water running down the glass tube in innumerable pellucid drops in the most beautiful manner, thus perfectly imitating the condensation of invisible watery vapour in the higher regions of the atmosphere. When the compo tube leaves the zinc vessel, it is led up perpendicular to the Lambert tap L. Above the tap L the tnbe still rises perpendicular, when it suddenly bends down, leaving the end open at M.

I now describe the part of the barometer helow the glass tuhe.

The compo tube being soldered on, was carried down to the cistern, not necessarily perpendicular; for instance, the tube may desceud at an angle of 30° or 40°, and may be led in any convenient direction. The entire instrument erected by me is in the honse, to escape a freezing temperature. At the lowest bend of the compo tube is a short upright tube, having at the end a Lambert tap N, to which is soldered a male screw of a $\frac{3}{8}$in. gas union-joint O, the use of which will be understood further on. The compo tube now begins to ascend; aud at the top of the bend is another Lamhert tap P. Beyond this the compo tube bends down and reaches nearly to the bottom of the cistern, which is a oue-gallon white-glass narrow-mouth upright bottle R. The bottle rests upon a stand S, which moves up and down by means of a set screw T, acting through a stout shelf U U; and the bottle is kept steady by means of the two uprights W W, upon one of which is fixed the zero-point E.

I shall now describe the method of filling the harometer, which was as follows :—

Four gallous of water were carefully distilled, and heing put into a perfectly clean and new tin oil-can with a narrow mouth, the water was boiled for one hour over a bright fire, the object being to drive out the air. While still hoiling, two quarts of olive oil were poured in. This slightly increased the pressure in the water underneath, causing the last remains of the air to rise with the steam in jets or spurts through the stratum of oil. The instant ehullition was stopped, the oil closed over the boiled water, and it became hermetically sealed from the atmosphere. The contents of the tin can were now cooled, and the can X was placed above the top of the water-barometer. A piece of $\frac{3}{8}$in. gutta-percha tube Y Y, sufficiently long to reach from the can X above to below the very bottom of the barometer, was procured, and one end of the tube was put iuto the mouth of the can X, the end passing through the supernatant stratum of oil down to the bottom of the water underneath. At the other end of the gutta-percha pipe Y is a $\frac{3}{8}$in. tap, terminating with a $\frac{3}{8}$in. female screw union-joint Z. The gutta-percha pipe being in position, and hanging dowu as secn in the drawing, became a siphon; and the air being sucked out, the water at once came over, and was stopped from running away by turning the small tap Z. The female union-screw at Z being tightly screwed on to the male screw-joint O, the water was ready to enter the barometer.

The first thing to be done was to displace the air in the bend of the tube,

reaching from the tap N at the bottom, to the extreme end of the compo tube in the cistern R. This was done in the following manner:—The cistern or bottle was taken clean away, and filled quite full to the very brim with best olive oil; the three Lambert taps being all open, and the bottom end of the compo tube hanging down, the small gas-tap Z was opened; the water then began to ascend both legs of the barometer, and when it reached the tap P, it passed over and ran out of the end of the tube which was hanging down. At that instant the stream was stopped with the thumb, and, the tap Z being turned off, the bottle full of oil was brought to the thumb which stopped the end of the compo tube and kept in the water. The thumb supporting the tube was now put into the oil, and the end of the tube slipped down to the bottom of the oil. The bottle was then put into its place on the stand S, and the surplus oil being siphoned out, there remained in the cistern R about 3in. in depth of olive oil, the compo pipe dipping into it nearly to the bottom.

The next thing was to fill the longer part of the barometer, which was accomplished as follows:—The tap P being closed and the small tap Z opened, the water rapidly rose in the barometer; when the water had reached the opening M at the top, it was allowed to run a minute or two to carry any traces of air away which might have lingered in the tube. Tap L at the top, and tap N at the bottom being then securely closed, tap P was opened, and the column of water began to descend and to accumulate in the cistern R under the stratum of olive oil. As the column fell it was narrowly watched in the glass tube, but not a bubble of gaseous matter was observed. On examining the cistern R, it was found that the oil did not quite reach the zero-point E; more oil, therefore, was poured in till the zero-point E and the level of the oil were coincident. The graduated scale was now looked at, and it showed that the column of water was 400in. high, the mercurial barometer being 30·4in., and the temperature 67°.

In order to test if gaseous matter would accumulate in the vacuum-chamber, the gutta-percha siphon was allowed to remain in its place for some weeks, and four different times tap P was closed, tap N opened, with tap Z, thus filling the barometer up to tap L at top, which being opened allowed the water and gaseous matter, if there had been any, to flow out at M. On closing tap L and tap N and opening tap P, the column of water again fell; and after siphoning out the surplus water from under the oil in the cistern till the oil was level with the zero-point E, the column of water was found on the four different trials to be exactly the same height on the scale after each trial as before. It was therefore plain that no gaseous matter had accumulated above the water, and that, with the exception of the vapour of water, it was a perfect vacuum.

I will now mention one or two precautions which are required in order to ensure success. In the first place the water must be distilled—for this reason, amongst others, that if the water contains "earthy salines" or colouring-matter, it is certain, by the constant evaporation and precipitation in the working part of the glass tube, to crust it over so completely, that in a few months the water becomes invisible; pure distilled water is therefore indispensable. Then, if the slightest leak in the barometer exists, it will infallibly bring the instrument to grief. In order, therefore, to be sure that the barometer was sound (before the water deprived of air was put in), I closed tap L at top and tap P; then, connecting the gutta-percha tube with the "street waterworks" pressure, I allowed it to enter the barometer till the included air was contracted to one-fourth of its length, having a pressure of water under it of between 40lb. and 50lb. to the inch.

The barometer stood this internal pressure for ten hours without the air being forced out. I therefore concluded that if the barometer would stand this great pressure inside, it would stand 14lb. to the inch pressure on the outside, and without hesitation I filled it with the prepared water.

As the instrument is made by a gas-fitter, it would be easy to put the whole of it together, Lambert taps included, and to prove it with some powerful water-pressure before the instrument is taken to the place where it is to be erected. Also the water deprived of air and covered with the stratum of olive oil in the tin can could be sent, if necessary, 100 miles away without the possibility of any air getting into it. If a gutta-percha pipe is not to be had to fill the barometer, a piece of compo tube will answer every purpose, which, when done with, is none the worse for gas-fitting purposes.

I shall conclude with some account of the action of the water-barometer. In the "Philosophical Transactions" for 1832 is a description by Mr. Daniell of a water-barometer which he erected at the "Royal Society's Rooms," at Somerset House, which was in action for two years, but afterwards got out of order. In describing the action, Mr. Daniell states that "the water appears to be in perpetual motion, resembling the slow action of respiration."

I can fully corroborate Mr. Daniell in this particular, and, from careful and continued observation am able to state that the times of the oscillations are about every four minutes and twenty seconds. It is requisite to watch the oscillations with a magnifier, as they vary from the twentieth to the thirtieth part of an inch, which distance can be well observed when it is slightly magnified. But the most surprising oscillations in the water barometer are during a thunder storm, accompanied with great falls of hail and heavy rain-drops. I have given a chart of five minutes' readings for one hour and five minutes during a heavy thunder storm from the north-east, which passed over Birmingham July 20th, 1859. The upper curved line shows the water oscillations, and the lower curved line shows the oscillations in the mercurial barometer. The temperature is recorded at the foot. It will be observed that while the water column rose and fell in a most surprising manner, the mercurial column showed hardly any motion, which was of a laggard character.

At 4.20 p.m. the storm reached its climax, the heavens grew darker overhead, and the water rapidly descended, causing a most impressive feeling on the mind, when suddenly came a terrific blaze of lightning instantly followed by the "thunder cannonade" (if I may so call it); then down came the hail and heavy rain, and as the sky began to brighten the water commenced to rise, and in the next five minutes it had risen more than four-tenths of an inch.

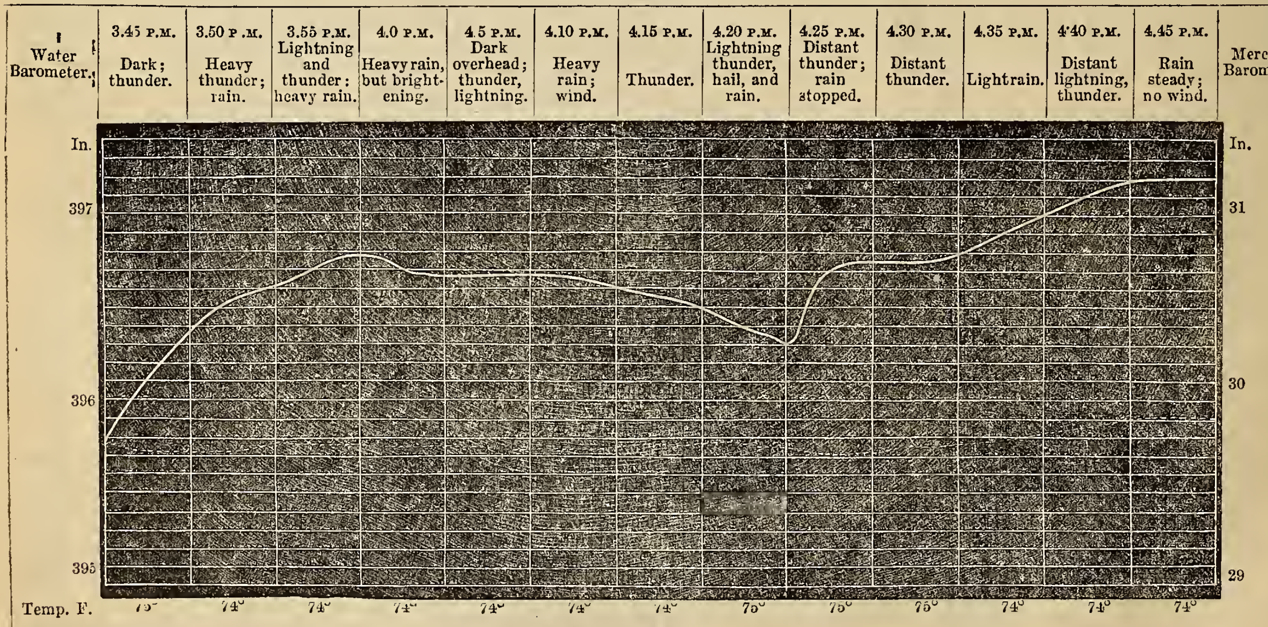


Chart of one hour and five minutes' readings of the Tidal Oscillations in the Water Barometer, during Thunder Storm, July 20th, 1859.

Since Sir John Herschel proposed his new theory—that the disruptive electric discharge is the result, and not the cause of the sudden condensation of cloud into "rain-drops," in consequence of the cloud coming in contact with an extremely cold and dry current of air—it has occurred to me that the sudden increase in the density of the air, as shown by the rise of the water-column, may be due to the sudden precipitation of rain-drops of unusual size, leaving the atmosphere drier and consequently denser; it being well established that the mercurial column is always high when the air is dry, and *vice versâ*.

I conclude this account of the water-barometer by stating that the object with which it is written is to give practical directions for the construction of these noble instruments with a view to their becoming common for the furtherance of meteorological science.

I just add that the total cost of the matcrials need not exceed £3, exclusive of gas-fitter's time.

INSTITUTION OF ENGINEERS IN SCOTLAND.

(With which is incorporated the Scottish Shipbuilders' Association.)

ON A PATENT DUPLEX SCREW PROPELLER.

By Mr. Arthur Rigg, jun., Chester.

Communicated through Mr. Jas. R. Napier.

If the action of a screw be observed, especially where it is only partly immersed, it will be seen that a powerful current is sent backwards; and experiments conducted by Mr. Robert Griffiths and the writer have shown that this reverse current holds good over the entire area of the screw, and that the power of the engines is expended in driving a cylindrical column of water backwards, in addition to propelling the vessel forwards. The engines are, therefore, employed in separating or moving apart two weights; the weights in this instance being the vessel on the one hand, and the column of water on the other.

Such being the case, it requires no argument to prove that the resistances overcome are precisely equal in opposite directions; thus, therefore, a column of water with smaller area must move proportionally faster to give an equal result with one of larger area; so it would seem that by merely accelerating the velocity and increasing the pitch, or the number of revolutions, it might be possible to get as much propelling power out of a small screw as a larger one. It is, however, well known that such a result by no means follows; and the causes of this apparent discrepancy form the most important subject of our present inquiry.

It will be said, "How can the fact be accounted for, that in well-proportioned screws the motion of the vessel corresponds very nearly with that of the screw?" Also, "Even in some cases exceeding it, as in negative slip."

The screw propeller bears no resemblance to a common screw and nut; in fact, it is much more like the paddle, but entirely submerged. The paddle moves exactly in the line of the vessel's course, but the screw propeller blades move at right angles to the vessel's course. Suppose, for illustration's sake, we look at a screw propeller 6ft. diameter, with, say, a boss 2ft. in diameter. With each revolution the extremity of a blade makes a circle of 18ft. in round numbers, while the root of the blade makes 6ft. Without professing to be accurate, we may take the mean speed of the blade to be

$$\frac{18 + 6}{2} = 12\text{ft.}$$

Now, as the blade cannot be set at an angle of 90° to the screw shaft, there must of necessity be a movement of the water at a certain inclination, and not exactly backwards. Measuring the velocity of the blade circumferentially seems to be the correct way of ascertaining the true effect of the screw propeller. I am fully persuaded that this is the only correct system to work upon. Accepting this theory for the moment as correct, a simple and natural explanation elucidates all questions of slip both positive and negative. If the water moved backwards offers less momentum than the ship forwards, the result is positive slip; if more, we have negative slip.

The series of experiments above referred to were conducted on a small screw steamer called the *Dagmar*, on the River Dee, at Chester. This steamer has one of Mr. Griffith's screws, 3ft. 6in. in diameter; and its usual employment is towing flats on the canal. Our experiments were conducted in order to ascertain the direction and pressure of the reverse current; and we ascertained these particulars by a small iron flag or apparatus like a wind vane, which had a long verticle spindle connected with it, and at the upper end of the spindle was an index finger, so arranged that the flag or vane could be set behind the screw in the water and adjusted to any radius, while the index finger moved in a graduated arc on the deck of the vessel. The area of the vane was exactly 10 square inches. It was first placed so as to determine the direction of the current, and then set at right angles to it, so as to obtain the amount of pressure, which was measured by a Salter's spring balance.

Three sets of experiments were conducted (see Table):—

First. The vessel propelling itself only.

Second. Towing a large flat.

Third. Fixed by the towing rope to a post.

For simplicity of comparison we will take notice only of one radius, namely, 17in., under the three different heads, and reckon the angle of deflection of the water from the line of the screw shaft; thus, if it were driven directly backwards, the angle would be zero.

First. With the vessel propelling itself only. The angle of the water driven off from the screw at 17in. radius was 35°, and the pressure of the current 21lbs. on 10 square inches, the screw making 144 revolutions per minute.

Second. While towing a loaded flat. At 17in. radius the vane showed a current making an angle of 45° with the line of screw shaft, while the pressure on 10 square inches was reduced to 10lbs., and the speed of the screw rose to 160 revolutions per minute.

In each of the foregoing experiments the steam pressure was 60lbs. per square inch, but in the next experiment it was 46lbs. per square inch.

Third. While moored to a post. The deflection of the current at the same radius gave an angle of 72½° to the line of screw shaft, and the pressure upon 10 square inches was reduced to 4lbs., while the screw made 136 revolutions per minute.

We must bear in mind that these pressures are measured at right angles to the *currents*, and not at right angles to the line of screw shaft, and they show that as the angle at which the water is deflected increases, so proportionably does the pressure of the current decrease.

Thus—With a deflection of 35° we get 21lbs. pressure.
With a deflection of 45° we get 10lbs. pressure.
With a deflection of 72½° we get 4lbs. pressure.

Comparing the first two together, an increase of 10° in the deflection reduces the pressure by 11lbs.; and comparing the latter results, an increase of 27½° reduces the pressure by 6lbs. It would appear from these facts that with no deflection all the power of the engines becomes pressure backwards, while with a deflection of 90° the current has its course or direction changed, and no pressure whatever; thus, calling the total pressure 50 for the sake of comparison, we have—

Angle of deflection = 0°; corresponding pressure = 50.
" " = 90°; " " = 0.

At the end of this paper is appended the complete table of results at the different radii—all taken below the centre of the screw shaft. I would only say that the results vary so conspicuously that I have found myself completely baffled in any attempt to ascertain with accuracy a law to account for their deviation; though this much is quite clear, namely, where we have little deviation there is pressure, and where all is deviation there is no pressure.

The power may be expended either in deflecting the current latterly, or in sending it back in straight lines, but it cannot do both. Take the case of a turbine, with a current of air flowing through it. When the machine is working to the greatest advantage the current passes away from the buckets with no velocity or pressure, and exactly at right angles to its course on entering. If it leaves at any smaller angle, unconsumed power passes away, and if at more than 90° from the direction of its course on entering, part of its own power is employed in deviating the current beyond the maximum of duty. Leaving the illustration which might be drawn from the latter case, as being in the main rather theoretical, we notice that in the turbine we have a mere change in the direction of the current of the water, while it impinges against the moving bucket, delivering out all the power contained in it. By reversing the process, and applying it to the screw-propeller, we see a portion of the power is employed in changing the direction of the current obliquely, while another portion gives a pressure that propels the vessel on its course. Besides the obliquity of motion of the water, consuming power to produce it, there will also be a loss from the very obliquity itself, and if it were not for the counteracting influences of the upper and lower oblique currents behind the screw, a vessel would be continually turning round and make a circular instead of a direct course.

Applying the angular deviation of the water to the entire circumference and area of the screw, it will be observed that the column hitherto spoken of as being driven backwards, really possesses a considerable twist or rotary motion as it leaves the screw; and it is by making use and taking advantage of this rotation that the power expended in producing it is delivered to the patent fixed blades, and assists in the propulsion of the vessel, instead of being wasted. True, no power can be recovered not originally given out by the engines, but when the stream has left the blades of the screw the total available power is represented by the water driven off, and all is contained in it, but a part of the power so contained moves the water sideways instead of the vessel forwards. When a screw-propeller revolves but slowly, there is not much side movement of the water, nor much twist in the column; but with an acceleration of the velocity, or increase of pitch, this obliquity increases, until at last it reaches such a degree that the propelling power will scarcely keep the vessel's head to the wind. Thus with a screw propeller there is always a limit of speed that must not be exceeded; consequently large vessels require large and ponderous screws, while, if it be possible to direct the current straight backwards with any velocity of the screws, we shall be able to reduce the size of screws at present necessary, and to increase their velocity and pitch within reasonable limits. It is not necessary to point out the advantage of such a system in shallow water; and the reduction of size and weight is a most important point under all circumstances.

The three experiments with the steamer propelling itself alone, towing a flat, and moored to a post, correspond with tolerable accuracy to a vessel with a large screw, a vessel with a small screw, and a vessel fast on a sandbank, or against a strong headwind. And reflecting on this comparison, it will readily be seen that, as the resistances increase, so does the power to overcome these resistances decrease. For this reason a screw propeller is no match for the paddles, either in economy, or scarcely even in speed; for on meeting with headwinds the screw still maintains its velocity, while the paddles reduce their speed; but the power of the screw is employed in twisting the column of water more and more.

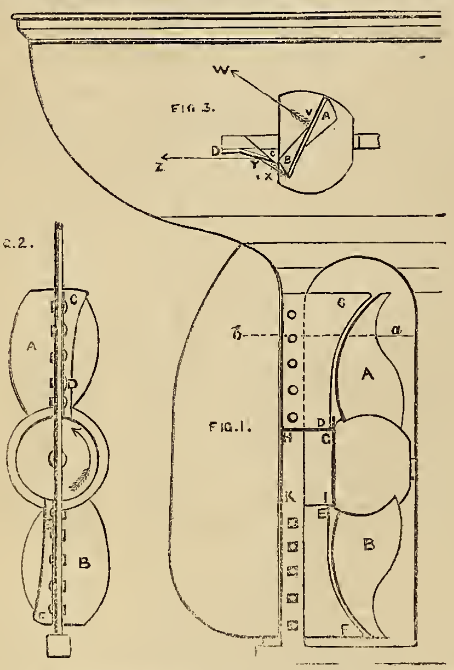
Having now arrived at the point where a twisted column of water is driven away from behind the screw, and seen that the angular portion of the line of its direction, or its obliquity, is a source of loss of power, we must consider how there can be a possibility of securing this power so wasted. Attention has naturally been directed to the screw itself to attain this object, and numerous and most costly have been the experiments conducted; and there is scarcely a shape that imagination can devise that has not been tried. The fins of fishes, the movements of their bodies, and the convolutions of shells, the Australian boomerang, and the wings of birds, have all lent their aid in attempting to solve the problem; but beyond a certain point all have failed. The reason of this is, that a screw has been looked upon as being what its name imports, whereas it really is not a screw in the ordinary acceptation of the term. And, moreover, as the plane of its movement must of necessity be always at right angles to the line of the direction of the vessel's course, the question of the

form of the propeller best suited, under present circumstances, is decided as that which gives the minimum of waste. Yet there must be some, and nothing ever can be done to the screw itself to reduce this minimum to zero.

Accepting this loss of force in the deviation of the current as a necessary concomitant to the nature of the screw propeller, we must try and recover the wasted power from the twisted current; and the apparatus for doing this is the patent duplex propeller which I have the honour of bringing before you.

Referring to the accompanying woodcuts, fig. 1 represents a side elevation; fig. 2, an end elevation; fig. 3, a transverse section across the line *a b*. A B is one of Mr. Griffith's screws attached in the ordinary manner. C D and E F are the deflectors bolted to the rudder post, and so placed relatively to the screw that the currents shall strike obliquely against the inner surfaces.

Referring to the section, fig. 3, the arrows *v w* and *x y z* represent currents of water driven away from the screw; *v w* being the ordinary course pursued by the current, and *y z* the course followed after impinging upon the surface of the deflector.



Two blades are shown in the drawing, for the sake of avoiding needless confusion; but the open space G H I K may be filled by a boss, and six, eight, or any number of blades spring from it, arranged similarly to those on the ordinary screw propeller.

We will assume a vessel to be fitted with one of Mr. Griffith's screw propellers in the ordinary manner, and that this propeller be driven at a tolerable velocity; and we will further suppose it to be a right-handed screw, with its blades set at 60° to the line of screw shaft. Now, behind this screw we place another exactly similar, but left-handed, and having its blades set at 30° to the line of screw shaft, instead of 60°. The boss carrying the latter is bolted to the rudder post, so that it can neither rotate nor move in any way, and the blades spring from it in the ordinary manner. The second screw catches the twisted column of water as it leaves the primary one, and diverts the currents straight backwards. I shall speak of it hereafter as the "deflector," and retain the name "screw" for that only to which it at present applies. This deflector is in itself a true screw, but with a very long pitch, and I have taken the figures 60° and 30° more for comparison than for accuracy. When the water has impinged upon the blades of the deflector, it passes away exactly behind the vessel, or in line with a continuation of its keel, and possesses little or no twist or obliquity. Bearing in remembrance the illustration of the turbine, it will be seen that the second deviation of the current gives out the powers which was needed to produce its first deviation, with, of course, the loss by friction. The whole apparatus, in fact, bears much resemblance to the Jonval turbine, and perhaps this is the most simple and convenient illustration.

It almost appears as if a current driven backwards should be more likely to force away the deflector, and cause an hindrance to the vessel's progress, instead of assisting; but this is not so, for we have suspended the deflectors loosely behind the screw, and find that when their angle or pitch is correctly proportioned to that of the screw, a strongly attractive influence is exerted, and the whole concern would be sucked into the screw were it not held fast by being bolted to the rudder post. We have gained both speed and an increase of towing force by the application of the "deflector;" and though hitherto the trials have been made on a small scale, several other points have been very strongly brought out; and they may all be traced to the fact that the water leaves in straight and parallel lines, and has no cross motion or obliquity. Thus, for instance, it does not strike against the rudder and produce the vibration now attendant on screw propellers only, for the force now employed in doing this is quietly led away, and aids in the progress of the vessel. Also, the parallelism of the current adds greatly to the ease of steering, and to the power of the rudder. There is also scarcely a perceptible confusion behind, as all cross currents which show a peculiar curling motion are taken away by the deflector, and produce useful effect in propelling the vessel.

The most important point, however, is the being able to dispense with the ponderous screws now necessary, and to secure any reasonable propelling power by the simple expedient of increasing the velocity of a small screw, and adding the deflector behind it; for although the power expended still produces a great deviation in the current, yet the deflector recovers all that would otherwise have been lost. We do not presume to create new power by this apparatus, but only to economise what is already produced by the engines, and to apply it all to propelling the vessel.

A model, showing the application of the invention in connection with a Griffith screw propeller, was exhibited.

Experiments on the Screw Steam Tug "Dagmar," on the River Dee, Chester,

To ascertain the deflection of the current behind the screw, and its pressure. 9th October, 1865.

Radii.	The vessel sailing alone.				Towing flat and cargo 65 tons.				Moored to a post.			
Below the centre of the screw.	Steam pressure.	Speed of screw.	Angle of deflection.	Pressure on 10 square inches.	Steam pressure.	Speed of screw.	Angle of deflection.	Pressure on 10 square inches.	Steam pressure.	Speed of screw.	Angle of deflection.	Pressure on 10 square inches.
17 inches.	60lb.	144 revs.	35°	21lb.	60lb.	160 revs.	45°	10lb.	46lb.	136 revs.	72½°	4lb.
14 ,,	,,	,,	27½°	18	,,	,,	37½°	13	,,	,,	52½°	8
11 ,,	,,	,,	25°	15	,,	,,	31°	13	,,	,,	50°	13
8 ,,	,,	,,	25°	12	,,	,,	31°	14	50lb.	144 ,,	45°	11
6 ,,	,,	,,	27½°	12	,,	,,	31°	9	,,	,,	42½°	...

HOWLETT'S PATENT ANEMOGRAPH, OR SELF-RECORDING ANEMOMETER.

The want of an instrument of a portable kind, to register the direction and force of the wind having been long felt, Mr. Howlett has patented such an instrument, the subject of the present notice, which he terms the "Anemograph," by the use of which the action of the air is recorded in the form of a map.

Fig. 1 is a view of the instrument, supposed to be fixed on an ornamental pedestal like a sun-dial. When required to be used as a field instrument a strong stand is supplied, having a horizontal motion, to enable the instrument to be placed on the meridian.

a. The base of the instrument is a slate, 12in. square and 1in. thick; on which is engraved a circle 10in. in diameter, divided into degrees, and figured from 0 to 360. Upon this base is fixed a square pyramid made of zinc, having a window on each side, and closed by a shutter.

b. A brass tube, forming a lever, working in a gimbal as a fulcrum in the top of the pyramid.

c. A pencil or tracer, of a proper weight, working freely in the brass tube.

d. A sphere capable of being moved up and down; and of such a diameter, that the pressure of the wind on its hemisphere shall be equal to the whole or any required portion of a square foot; of course taking into account the ratio of a hemisphere to its great circle when pressed by a fluid.

e. A weight so adjusted with reference to the sphere, as to cause the pencil to express pounds of pressure on the square foot by its distance from the centre

of the graduated circle, according as the sphere is down, up, or up with a weight f at the top, thus giving three scales.

When the sphere is down, the scale of pressure is 0 to 20lbs. on the square foot; when up, the scale is 0 to 5lbs.; and when up, with the weight f on, the scale is to $2\frac{1}{2}$lbs. A wooden measure graduated to these three scales, by actual trials, is attached to the instrument.

For ordinary registers, kept daily all the year round, the sphere should be always down. The other two scales are for experiments, under personal superintendence, on light winds; which have never yet, it is believed, been investigated for want of an instrument that will give correct results.

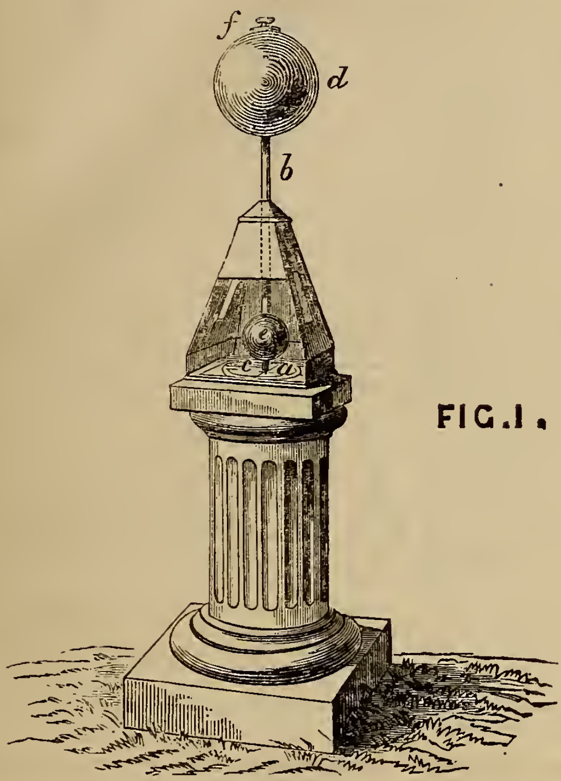


FIG. 1.

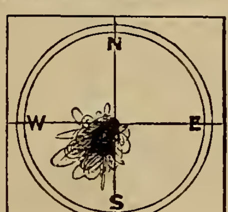


FIG. 2.

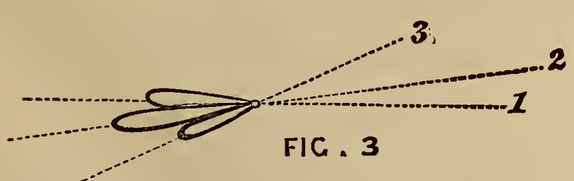


FIG. 3

In action, the pencil throws out from the centre, or zero, a line in the direction the wind comes from, and, in returning, a loop or curved line is formed, and the force of the wind is indicated by the length of the line or loop; so that by laying the wooden scale against the centre of the slate and the end of the loop, the force is read on the edge in pounds pressure on the square foot, and the angle at which the current of air crossed the meridian is at the same time found in degrees on the divided circle.

The greatest pressure here provided for is 20lbs. on the square foot, which is sufficient for the winds that occur in this country, as proved by careful experiments.

This instrument is strong enough to bear any hurricane; and to measure any force above 20lbs. nothing more is necessary than to increase the weight marked e, in fig. 1, in a certain proportion.

Fig. 2. The part shown black represents the manner in which either a breeze or a storm is recorded, the salient points of which mark the direction and force of the principal currents, which are to be measured by applying the proper scale as before directed.

Fig. 3 shows a remarkable fact which this instrument brings to light. If while the wind is blowing, the pencil be held on the centre of the slate, and then let go for a few seconds only, we get a figure consisting of several loops, as shown by the dark lines; from which, probably, no other conclusion can be drawn than that the wind moves on in circles which are constantly crossing the paths of each other, as shown by the lines 1, 2, and 3. It appears almost certain that if a sufficient number of these instruments were employed in positions accurately marked on a map, that the courses of these circles and their diameters might be laid down on a map, and so, by studying the small circles, a better knowledge of the law of storms could no doubt be obtained.

Maps on common paper may be drawn by the instrument either with black lead pencil or blue chalk pencil; or they may be made on common paper by an agate or a brass tracing point working on carbon paper.

The observer, therefore, can take his choice, either to look at the work on the slate and then rub it out, or to obtain daily maps on paper which would show in a striking manner the action of the air throughout the year; and the instrument also gives the power of trying experiments that it is hoped will some day lead to important discoveries.

The form of the instrument here described is intended to be as portable as possible; but it intended to be fixed, the pyramid of zinc might easily be so extended as to give cover for the papers and materials.

When intended to be fixed, of course the instrument should be set on the true meridian; but, when used as a field instrument, it may be set on the magnetic meridian like a circumferenter, for which purpose a needle may be sunk in the side of the slate, or a convenient compass provided.

A few specimens of work done by this instrument, with some practical memoranda, may, we are informed, be seen at the makers, Messrs. Elliott Bros., Strand.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The thirteenth annual meeting of this society took place on the 13th ult. at its rooms, in Doctors' Commons, City, Mr. Joseph Newton, of the Royal Mint (President) filling the chair. The attendance of members on the occasion was very large, and the principal business transacted consisted in the reception of the auditors' report for the past year, and the appointment of officers for the year ensuing. The report demonstrated the fact most conclusively, financially and numerically, that the institution is in a very healthy condition. The amount of moneys invested for meeting the ordinary expenditure was stated to be £426 10s., the number of members 145, and the stock purchased for the purpose of granting superannuation allowances to aged, infirm, and necessitous members was shown to be equal in value to £600. Details, explicit and complete, of the year's income and expenses were given, and after a brief discussion the report was unanimously adopted.

Mr. Newton then proceeded to deliver the annual address from the chair, and in doing so took occasion to review the incidents of the year in connection with the association at considerable length. He further introduced biographical notices of three members—Messrs. Haley, Hill, and Stanley, all of whom had been present at the previous yearly meeting, but who had since then been removed from the cares, the joys, and the sorrows of this world. The particulars furnished in regard to these gentlemen were of an interesting nature, and, as in the case with foremen engineers generally, they had all risen from the ranks of the mechanical class, and achieved for themselves honourable positions. The circumstances attending the death of Mr. Frederick Hill were of a peculiarly melancholy character. He was in the service of Messrs. Merryweather and Sons, the celebrated constructors of steam and hand fire-engines, and on August 12th last had gone, at seven o'clock in the evening, to visit his master, who was confined to his suburban residence by illness. Mr. Hill remained with his employer until 10 p.m., and while in the act of crossing the road to take an omnibus, the driver of which was impatiently urging him to make haste, he was struck down by a vehicle rapidly driven from another direction; one of the wheels passed over the body of the unfortunate gentleman, Mr. Merryweather himself witnessing the accident. The sufferer, in an insensible state, was promptly borne into the house from the door of which a moment before he had issued cheerful and well. Surgical attendance was procured immediately, his family were sent for, and all that could be done by sympathising and sorrowing friends was accomplished. Every effort, however, was vain, and in a few hours Mr. Hill, who at the time was only forty-one years of age, ceased to exist. Unfortunately (said Mr. Newton) he has left a widow and four young children, with but slender, if any, provision; although Messrs. Merryweather and others had acted very generously towards the bereaved family, and the members of that institution had aided them to some extent, he feared they were at present in a state of considerable pecuniary embarrassment. It was, in truth, a case deserving of consideration apart from the profession, of which Mr. Hill was a very worthy and talented representative, and he trusted that the press, scientific and otherwise, might make these facts public. He himself (Mr. Newton) should feel a pleasure in receiving and forwarding to Mrs. Hill any further subscriptions for her advantage. The President next reverted to his own position in respect to the association, and earnestly requested that his resignation of the office, to which he had been re-elected on seven successive occasions, should be now finally and definitively accepted. He had served a good old-fashioned apprenticeship in that chair, was duly out of his time, would like to have his indentures, and wished to give place to a better man. Mr. Newton then formally vacated the presidential post, and retired from the meeting. His absence was brief, nevertheless, for it was shortly after proposed by Mr. Usher, seconded by Mr. Briggs, and carried unanimously, "That Mr. Newton be requested to resume his office for yet another year." A

deputation waited upon the President elect to inform him of this resolution, and, in conformity with it, Mr. Newton once more, amid very palpable demonstrations of approval, seated himself in his old place at the head of the Council of Associated Foremen.

Mr. Sanson was elected vice-president, Mr. David Walker secretary, and Mr. Meredith Jones treasurer for the year 1866.

Subsequently it was announced that the anniversary dinner of the society would take place at the Freemasons' Tavern on the 17th inst., and that John R. Ravenhill, Esq., C.E., would preside thereat.

PETROLEUM IN EUROPE.

The erroneous impression under which many laboured for some time as to the sources of the supply of petroleum oils being confined to America, has been gradually removed, thanks to the researches of scientific and practical men of high standing, whose labours must prove of great value in having dispelled the false alarm which many felt at the supply of this now important item of general consumption falling short from the oil wells of America failing to give the necessary yield. And we may therefore trust that, as in the case of the supply of cotton, there are vast sources of supply of petroleum diffused throughout Europe alone, independently of the West.

Foremost amongst those who have laboured most zealously in the direction we have indicated, we may mention M. Felix Foucou, of Paris, with whose name most of our readers are doubtless familiar, from what has already appeared in the pages of THE ARTIZAN in connection with this subject. Following up what we have already quoted from M. Foucou, we now give a translation of an article recently written by M. Foucou, and which appeared in our foreign contemporary, the "Sémaphore de Marseille."

We now quote M. Foucou:—

The price of petroleum has so much increased during the last few months that the present moment may be considered highly opportune to make searches for this commodity on the continent of Europe. No doubt the apprehensions of speculators that the oil wells of America are becoming exhausted are devoid of foundation: but then the market for petroleum is extending with such a wonderful rapidity. Countries which a few years since had never known the use of this oil, are consuming such vast proportions of it at the present day that the production is no longer equal to the consumption, the demand exceeds by far the supply, and we are called upon, therefore, to search for sources of supply our old continent, so rich in bituminous substances.

But should such researches be made at random? Are all regions equally appropriate for them? Should they be made indiscriminately, say in the plains of Paris or the hills of the Vosges? Would the same chances of success exist on the rocks of La Vista or Ratonneau as in certain alluvial grounds of Alsatia? A little reflection will teach that the extraction of petroleum is subject to the same conditions as that of coal, iron, sulphur, and other mineral substances: at one place it may be met with, at another it will be deficient, and a safe guide, in other terms a positive geological theory, is requisite to limit as much as possible the costs of the searches.

This guide is represented by Mr. Elie de Beaumont's theory of the pentagonal net. This net crosses all great ranges of mountains and all fractures of the globe. By collating all bituminous strata known to the present day it will be seen (as M. de Chancourtois has shown first) that the lines connecting these strata to each other coincide either with these ranges of mountains or fractures. For example, the chief strata of petroleum in the United States are situate in the prolongation of the fracture across which the St. Lawrence River passes, and this fracture, if produced across the Atlantic into Europe, will just terminate on a classical spot for oil wells, viz., at the peninsula of Aspheron, bounding the Caucasus range in the Caspian Sea near Baku.

This example is anything but a mere coincidence or exception. The same strata of Baku form with those of Elgin (in Scotland), a system that passes through the strata of Western Galicia and Hanover. I have shown heretofore (see THE ARTIZAN, Nov. 1865), that the layers of Eastern Galicia are situate in that fracture which crosses Europe in a curved line from the mouth of the Oder to that of the Danube, so that the Carpathian system of petroleum strata has two natural boundaries, the Black Sea and the Baltic. The strata of Alsatia and Avallon belong to the system of the Amazon, the Upper Danube and the Ural, whilst the line which connects the bitumen layers of the Auvergne with those of the Seyssel is strictly parallel to the system of the Netherlands.

This enumeration will prove sufficient to support the present theory in the eyes of the reader. The great movements of the crust of the globe, to which is due the creation of mountains, of all valleys, save those formed by erosion, and of the beds of the great rivers, have, no doubt, disseminated at the same time bituminous, metallic, and other deposits all along these lines of dislocation, or in their proximity. Therefore, being once given three layers in a straight line, there is ample foundation for searching after other layers in the same direction; and if these searches be properly conducted, petroleum may be discovered in abundance in localities where its existence was not before suspected.

The question arises, have these theoretical views of general geology been borne out in practice? for, if so, it would follow that by means of a system of lines determinated by known layers of petroleum, new layers should have been discovered.

This is just what has taken place last year. I am not alluding to the strata of Galicia, though they form at present the most striking proof of the fecundity of this method of searching. Thus, it is well understood that the explorers of that country may, with great advantage, push their investigations, first, in the directions of W.N.W. and E.S.E., when they are at the west of the line of separation of the waters of the Baltic and the Black Sea: second, in the directions N.N.W. and S.S.E. when they are at the east of the same line. But another practical example, which touches the trade of Southern Europe nearer home, and is circumscribed by a narrower boundary, will militate still more in favour of the present theory.

In October last a very important layer of petroleum was found at a depth of about 100ft., in the Abruzzi citeriori, on the eastern slope of the Apennines; and this discovery is due to systematical searches, undertaken under the auspices of two geologists of the peninsula. There existed previously a layer in the north, at Paretta, on the line connecting Bologna and Florence; and this layer, jointly with those of the Duchy of Parma, gave several points in a straight line, and a system parallel to the ridge of the Apennine mountains. Now, the layer recently discovered had been searched for in the very line of this system: it is therefore highly probable that, within a few years, many more oil wells will be discovered on the eastern slope of the Apennines, to the great profit of the refiners and consumers of the Mediterranean basin.

As regards the latter system, I may observe here that its general direction is from north-west to south-east, which is also the direction of the Thüringerwald system, pointed out by M. Elie de Beaumont as one of the great primary circles of the pentagonal net. This is also the average slope of the Carpathian system. The line that joins the oil wells of the Apennine system, produced southward, passes to the Island of Zante, celebrated for its oil springs since the days of Herodotus. It appears, also, at first sight, that the fracture through which the hydrocarbonated products of the Ionian Islands pass, is in connection with that formed by the reservoirs of the eastern slope of the Apennines.

This corroboration of the efficacity of the present method seems to me to be highly promising and encouraging to European explorers. There are already on our Continent two ranges of mountains, the Carpathians and Apennines, the eastern slopes of which contain vast supplies of mineral oil. I have mentioned heretofore other lines less productive, but still highly lucrative and suitable for searches. On a future occasion I may have to speak of other eruptions pregnant with mineral wealth, in the south of France, the bituminous properties of which have been known for several centuries, and can hardly fail to be appreciated nowadays.

I may as well mention here that liquid petroleum is to be found (at greater or less depths) at the bottom of almost all those places in which bituminous layers are met with at the surface. To discern petroleum in such places, the whole difficulty lies in obtaining and using appropriate tools. A deep sounding should never be shunned under such circumstances. The petroleum of Enniskillen, Canada, has not been struck in any other manner. The same may be said of that of Kertch, in the Crimea, and of many other strata.

One more item of news before I wind up. A rich petroleum spring has just been discovered in the Government of Archangel, near one of the tributories of the Petchora River. The oil extracted from it may be easily conveyed to the interior of Russia, as far as Kama, by common roads, and from there to the Governments crossed by the Volga.

All these facts bear a promising aspect as regards a plentiful supply of "petroleum in Europe."

THE LOCKE MEMORIAL.

On the 18th ult. the ceremony took place of unveiling a statue, by Marochetti, of the late Joseph Locke, C.E., M.P., &c., erected in the People's Park, at Barnsley—a plot of ground presented to the town by Mr. Locke, with a liberal endowment for its maintenance.

The ceremony was performed by Lord Alfred Paget, assisted by the principal authorities of Barnsley and a large body of the neighbouring gentry, and supported by Mr. Fowler, the President of the Institution of Civil Engineers, and a goodly assemblage of engineering friends from London.

A procession was formed in the Church Field, and proceeded to the park in the following order:—

The 4th Administrative Battalion of the W.R. Rifle Volunteers, with their several bands.
Constables of Barnsley, five abreast.
The Clergy and Ministers of all religious bodies, two abreast.
The Magistrates.
The Captain of the Locke Scholars.
The Locke Scholars three abreast.
Members of the Local Board of Health.
Lord Alfred Paget.
John Fowler, Esq., the President of the Institution of Civil Engineers, and the Friends of the late Mr. Locke.
The Inhabitants of Barnsley attending, three abreast.
Clubs four abreast.

On arriving at the site of the memorial, the Rev. W. J. Bender offered up an appropriate prayer, and the statue was unveiled.

Lord Alfred Paget then, as Chairman of the Memorial Committee, addressed the assembly in the following lines:—

Gentlemen, it is not without considerable hesitation that I have consented to take an active part in the proceedings of this day. I had hoped that some celebrity in the scientific or political world would have performed the duty which appears to have devolved upon me, in the capacity of chairman of the committee of the friends of the late Mr. Locke, who had combined to raise this not unworthy tribute to his memory. I was, however, easily persuaded, as I entertained a personal regard for our late friend—(Hear, hear)—and having the good fortune to be thrown much into his society, I fully appreciated the good qualities he possessed. (Applause.) No task could therefore be more agreeable

to me than aiding in paying a public tribute of respect to his memory in this locality, whence he sprung—where he was so well esteemed, and is now so deservedly regretted—and where, also, the joint names of Mr. and Mrs. Locke will be long gratefully remembered, for their judicious and munificent endowments of your public charities. (Loud and protracted cheers.) The public career of Joseph Locke is before the world in the great works of public utility projected and accomplished by him. We may, however, be permitted to cast a retrospective glance at the antecedents of the well-known public man, and in this case we shall find that in his father he had before him a model upon which he properly and sensibly formed his own character; for it is clear that the father and son were equally remarkable for energy and steadfastness of mind, combined with economy and sagacity in worldly affairs. (Cheers.) Joseph Locke was born at Attercliffe Common, not far from hence, in the year 1805, and at a very early age came with his family to Barnsley, where he enjoyed the advantage of the tuition of the Grammar School. But in these days the period devoted to education was not long, and he was soon sent to learn the profession of surveying, at Pelaw, and afterwards at Rochdale, and was then engaged in assisting his father. In the year 1823, by a fortunate combination of circumstances, the attention of the late Mr. George Stephenson was directed to the son of his old fellow-workman, and young Joseph Locke was admitted into the engine works at Newcastle-upon-Tyne. To a hard working and studious youth, the opportunity thus afforded of participating in the great and novel works of the day, and in company with such a man as George Stephenson, was not to be neglected. Self-help was all he had to rely upon, for in those days there existed but little of the ideas so readily found at the present time. He shaped out his own course, and the energy of his character led him on to fame and fortune. Joseph Locke, already an accomplished surveyor and an active colleague of Robert Stephenson in asserting the superiority of the locomotive over the proposed stationary system of traction, was soon permitted to take his own course; and in 1835 he constructed the Grand Junction Railway, which, by its great commercial success, first strongly attracted the attention of capitalists to railways as a highly profitable kind of investment. The career of Locke thus auspiciously opened, soon became of incessant occupation, as mercantile men and the *bonâ fide* shareholders demonstrated their confidence in him, by subscribing largely to the lines on which he was engaged. (Loud cheers.) The South-Western, the Sheffield and Manchester, and then the Scottish lines uniting the two capitals, London and Edinburgh, were commenced and successfully carried out. In 1837 he began the railways north of the Tweed, and thus were forced upon him works of greater magnitude than he would otherwise willingly have undertaken, for the great characteristic of his engineering mind was to avoid all works, however interesting, which were not strictly essential to the welfare of the undertaking. (Hear, hear, and cheers.) In these connecting links between north and south, the features of the intervening country forced upon him the construction of steeper gradients, which he henceforth adopted. In 1838, at the instigation of M. Lafitte, he turned his attention to the construction of railways in France, and with Messrs. McKenzie and Brassey as the contractors, he successively executed the Paris and Rouen, the Rouen and Havre, the Rouen and Dieppe, and the Cherbourg Railways—as well as co-operating in other lines, and giving the impetus to the introduction of the railway system into France. These services were recognised by Louis Philippe and by the present Emperor when they successively created Mr. Locke a Chevalier and Officer of the Legion of Honour. About the year 1849 he became the representative in Parliament for the borough of Honiton, for which he sat thirteen years, and enjoyed the full confidence of his constituents. We have not to deal with Joseph Locke as a politician or a legislator, or I might be tempted to enlarge upon the consistent support which he gave to the free trade movement—(Hear, hear)—his sensible opposition to the Sunday Bill, and the pertinacity with which he urged upon the House the importance of obtaining full and careful estimates for the public works which were sought to be authorised. (Cheers.) The time must arrive when the strongest mind and the most active frame require repose, and Mr. Locke gradually relaxed his business and Parliamentary avocations, still, however continuing to be the valued adviser of certain railway companies; whilst at other times he appeared at the annual public meetings as a severe critic of their proceedings when their policy was not identified with his views. (Cheers.) He interested himself in several useful charities, and devoted to the Institution of Civil Engineers even more attention than he had previously done, probably with an inward feeling that in the removal of Cubitt, Rendle, Brunel, and Stephenson, it was incumbent upon him to watch over that Institution which had been their constant care. (Loud cheers.) His address from the Presidential chair should be in the hands of every young engineer. Gradually, however, he withdrew more from public life, and devoted himself to country occupations and field sports, which, on the Scottish moors, he highly enjoyed. You, men of Barnsley, always occupied much of his thoughts, and when he visited this place you gave him a most cordial welcome, listened to his advice and pleasant jokes, expressed to him the wants of your town, and in all ways treated him as a trusted friend and counsellor, and right well he merited your confidence. He went home fully imbued with the feeling of what should be done for the benefit of your town, and Mrs. Locke has religiously carried out his views—you know how thoroughly she has acted in accordance with those views in the free gift of this ground, the Locke Park, with an endowment for its maintenance, a most liberal endowment for the Grammar School—whence he derived rudiments of education—a munificent gift to the Roman Catholic Schools, and other well-considered and well-bestowed charities. These all attest the kind intentions of Joseph Locke, and the noble manner in which that excellent lady, Mrs. Locke, has carried them out. (Loud cheers.) My mission must end with the expression of regret we all feel at the too early removal of the last of the trio of Brunel, Stephenson, and Locke, all men who had done and were still calculated to do good service for their country. (Hear, hear.) Allow me, in conclusion, to congratulate you on the auspicious inauguration of this noble monument to the memory of your distinguished townsman in the centre of this beautiful park, and in the sight of your children who may be taught by it lessons of energy, self-reliance, and public usefulness—and to express my admiration of this fine work of art by Baron Marochetti, which we now entrust, with confidence, to your safe keeping. His lordship concluded amidst loud and protracted cheering.

To a resolution thanking the donors for the statue, Mr. John Fowler, President of the Institution of Civil Engineers, said:—

Gentlemen, on behalf of the donors who have presented the statue to the town of Barnsley, permit me to thank the inhabitants for the resolution which has just been read, and at the same time to assure them that, in the opinion of the friends of the late Mr. Locke, the statue has now been placed in its best and most appropriate position. Such a memorial of such a man can scarcely fail to exercise a beneficial influence on the future career of many young men of this busy district, besides being in itself an ornament to the town. The admirable address which we have heard from Lord Alfred Paget, has left little to be added by those who follow him. Personally I esteem it a great privilege to be present at the interesting proceedings of this day; and I am sure it must be a subject of peculiar gratification to the friends of the late Mr. Locke, as it is to myself, that one who knew him so well and valued him so highly, and who is himself so much respected by the engineering profession as Lord Alfred Paget, should have consented to take such vivid personal interest in the realisation of this record of our late friend, and also in taking the chief part this day in the inauguration of the "Locke Memorial." I can assure the inhabitants of Barnsley, and the numerous friends and admirers of Mr. Locke now assembled here, that the members of the Institution of Civil Engineers of England, of which I have now the honour to be President, take a deep interest in these proceedings, and that they sympathise cordially in the respect thus rendered to the memory of a man whom they will long remember as one of their most distinguished and useful Presidents. The world justly thinks that the days of Stephenson, Brunel, and Locke were "days of the giants" of the engineering profession; and, gentlemen, allow me to say that we, in the present day, entirely agree with the world at large in that opinion. Locke was truly one of those giants. His far-seeing and strong common sense, his comprehensive grasp of all the bearings of a question were so powerful, that the capitalists of Lancashire, of London, and ultimately of France and the continent of Europe, placed faith in his judgment, and then followed him with such confidence as to entrust almost unlimited capital to his disposal in every undertaking in which he engaged. In France he was the pioneer of the railway system of that country, and had the good fortune to be accompanied and seconded by Mr. Brassey, whom we are all delighted to see present with us this day. What more fitting representatives of Englishmen could be found than the prudent but energetic Locke, and the modest but lion-hearted Brassey? What, indeed, but a lion heart enabled Brassey to meet the great catastrophe of the fall of the Barentin Viaduct? an accident, a pure accident, for which he was neither legally nor morally responsible. "Well, Brassey, what is to be done?" says Locke. "Why, my dear Locke, of course I must build it up again;" and build it up again he did. Those were the true kind of men, gentlemen, to be the pioneers of a new enterprise, and to impart confidence in Englishmen amongst foreigners. But, gentlemen, let it not be supposed that Locke was merely a commercial engineer. I believe that, to some extent, injustice has been done to his memory by those who did not know him well, arising, no doubt, from the prominent development of the common sense and commercial element in his character. Locke was, however, an eminently scientific engineer, and it is to his scientific knowledge we owe some of the most important discoveries and improvements in our railway system. He it was who first abandoned the use of the fish-bellied rail and adopted the I form of rail, and he was enabled to do this entirely from his scientific knowledge of the true value of what engineers call "continuity." He it was who, in conjunction with Robert Stephenson, combated the advocates of fixed steam engines as a means of obtaining locomotive power, and by their thorough knowledge of the locomotive engine and its capabilities obtained the victory in the contest. He it was who, by the confidence which perfect knowledge of the subject gave him, first advocated the lines over the mountain ranges between Lancaster and Carlisle, and between Carlisle and the north, by which means long tunnels at a ruinous cost were avoided, but at the same time obtaining perfectly good working lines, and thoroughly adapted to the nature and extent of the traffic required to be passed over them. At that time no engineer but Locke would have dared to make the proposals for such lines, and certainly no other engineer would have been followed and supported in them by adequate capital; and yet we all now know and acknowledge his views on this question to have been sound, notwithstanding the vehement opposition which they encountered at the time. What but scientific knowledge could have enabled Locke to arrive at such admirable conclusions? because, at that time, there was little or no experience to guide him upon such questions. Many similar instances could easily be given, but they would not here be in place, and I have only enumerated one or two prominent cases to correct the erroneous impression which has appeared to exist in some few minds, that Locke was not eminently a scientific engineer. Will you permit me, in order to illustrate one of the characteristic traits of our departed friend, to refer to the kindly feeling, and almost I might say affection, which many of us have so often witnessed between himself and Robert Stephenson when they met? They were, as is well known, frequently professional rivals, but always attached friends: and no one who had the privilege to hear it, will ever forget the alternate "Robert" and "Joe" of their familiar social intercourse in their late years, as in the old days long gone by. In conclusion, gentlemen, permit me to say, that from the career of the late Mr. Locke we may draw many useful lessons, and I hope as a Yorkshireman myself, his example and success will stimulate other young men of Yorkshire to similar efforts for the good of mankind, and for their own reward. Amongst civil engineers, and in the annals of the Institution, the name of Locke will ever occupy a distinguished position, and I believe the record of this day's proceed-

ings will be memorable as long as a great and useful man continues to be appreciated by England and Englishmen.

The proceedings were closed by the National Anthem, sung by the assemblage around, who were all deeply interested in the proceedings.

REVIEWS AND NOTICES OF NEW BOOKS.

A Treatise on the Screw-Propeller. By John Bourne, C.E. London: Longmans, Green, Reader, and Dyer. 1866.

We have received Parts 3 and 4 of Mr. Bourne's valuable work. Part 3 contains three plates: two of the screw-engines of the *Great Eastern*, and one of the direct acting screw-engines of H.M. gunboat *Shearwater*. The historical account of the screw-propeller is continued up to the date of 1839. Part 4 contains a plate of comparative views of direct acting screw-engines; and the historical account of the screw-propeller is continued and brought up to the date of 1844. The Appendix is continued in both numbers.

Mr. W. F. Stanley of Great Turnstile, Holborn, announces for publication, early in March next, "A descriptive Treatise on Mathematical Drawing Instruments, their Construction, Uses, Qualities, Selection, Preservation, and Suggestions for Improvement. With hints upon Drawing, Colouring, and Drawing Material, &c."

BOOKS RECEIVED.

"The Modern System of Naval Architecture." By J. Scott Russell, F.R.S., Vice-President of the Institute of Civil Engineers, and of the Institute of Naval Architects. 3 Vols. London: Day and Sons, Gate-street, Lincoln's-inn Fields. 1866.

[Mr. J. Scott Rossell's valuable and compendious work has reached us too late for notice, we regret, until our next issue.]

NOTICES TO CORRESPONDENTS.

Anson (Edinburgh).—To find the intensity of centrifugal force multiply the weight of the body by the square of the velocity in feet per second, and divide by 32·2 times the radius of the circle in which it moves.

A. Kerr.—The patents to which you refer are very similar, and we are of opinion that the latest is invalid, but they are neither of them of any practical value.

G. E. (Teignmouth).—To find the pressure in inches of water produced by the weight of your gasholder, divide the weight of the gasholder in pounds by the square of its diameter in feet by 4·1.

Sutor—Many locomotives constructed according to Crampton's patent are in use, but they are made lighter than the first on that system, which was tried on the London and North Western Railway.

W. Holt (Collumpton).—To find the proper thickness for cast iron roadway plates in inches, multiply the square root of the load in pounds per square foot by the length of the plate in inches, and divide the product by 380.

D. C. L.—Thanks for your offer. It is accepted.

R. (Glasgow).—The mistake has occurred from your confounding the gentleman in question with Mr. Alexander Gordon, M. Inst. C.E. Mr. George Grove, the secretary of the Crystal Palace, was a favourite pupil of Mr. Gordon's, and superintended the erection of the iron lighthouses at Bermuda and elsewhere.

Q. R. and S.—We cannot recommend either of the centrifugal pumps as suitable for the purpose. Write to Mr. James McEwan, Engineer, Glasgow, for information respecting the new apparatus, patented by him and a Mr. W. Neilson.

Alpha—The boiler designed by Mr. Thomson, of Edinburgh is more suitable for your purpose. The Field boiler is a very rapid generator

F. A. S. (Genoa).—The Iron Pontoon Company, about which you inquire, is a highly respectable affair. We are informed by the Secretary that it is identical with the Thames Graving Docks Company, of which Messrs. Bidder, Brassey, Capper, Clarke, Elliot, and Lord Cland Hamilton are Directors. The office is 9, Mincing-lane, London. We are unable to obtain the other information asked by you in time.

D. D. (Alexandria).—Messrs. Savory have been very successful in their application of steam-power to the cultivation of land. We do not know anything of Howard's new engine. We were not present at the trial.

F. C. S. (Melbourne).—We cannot assist you at present, but will endeavour to make up a complete set of "The Artizan" 2nd and 3rd Series, in which you will find a complete history of the improvements made in the marine engine, and all that can be stated about the Randolph and Elder engines, which have not yet been surpassed for economy.

C. Smith (Calcutta).—Mr. Bramwell's short paper on "The Theory of the Action of the Giffard Injector," read at the Birmingham meeting of the British Association, is perhaps the best. There have been one or two papers read since, mere advertisements of the author, and contain nothing new or useful upon the subject. Mr. C. Stewart, of Manchester, Mr. Robinson, and Mr. Bramwell have practically exhausted the subject.

D. C., R. S. & T., V. N. & Co., Margesson, Howlet, F. (Honkong), and other Correspondents, will either be replied to in our next, or be answered by post.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Jan. 6. £	s.	d.	Jan. 13. £	s.	d.	Jan. 20. £	s.	d.	Jan. 27. £	s.	d.
COPPER.												
Best, selected, per ton	109	0	0	109	0	0	104	0	0	99	0	0
Tough cake, do.	106	0	0	106	0	0	101	0	0	96	0	0
Copper wire, per lb.	0	1	1½	0	1	1½	0	1	1	0	1	0½
„ tubes, do.	0	1	2¼	0	1	2¼	0	1	1¾	0	1	1¼
Sheathing, per ton	111	0	0	111	0	0	106	0	0	101	0	0
Bottoms, do.	116	0	0	116	0	0	91	0	0	106	0	0
IRON.												
Bars, Welsh, in London, per ton	7	10	0	7	10	0	7	10	0	7	10	0
Nail rods, do.	8	15	0	8	15	0	8	15	0	8	15	0
„ Stafford in London, do.	8	15	0	9	0	0	9	0	0	9	0	0
Bars, do.	8	12	6	9	0	0	9	0	0	9	0	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	10	0	4	10	0	4	10	0	4	10	0
„ in Clyde, do.	3	6	0	3	6	0	3	8	6	3	6	9
LEAD.												
English pig, ord. soft, per ton	21	15	0	21	15	0	21	15	0	21	15	0
„ sheet, do.	21	15	0	21	15	0	21	15	0	21	15	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	22	10	0	22	10	0	22	10	0	21	0	0
BRASS.												
Sheets, per lb.	0	0	11¾	0	0	11¾	0	1	11½	0	0	11
Wire, do.	0	0	11¼	0	0	11¼	0	0	11	0	0	10½
Tubes, do.	0	1	0½	0	1	0½	0	1	0¼	0	0	10¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	14	0	1	14	0	1	14	6	1	15	0
IX „ „ „	2	0	0	2	0	0	2	0	0	2	1	0
IC „ 2nd qua., „	1	12	0	1	12	0	1	12	0	1	13	0
IC Coke, per box	1	7	6	1	7	6	1	7	6	1	8	0
IX „ „	1	13	6	1	13	6	1	13	6	1	14	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The Sewing Machine Patent.—Important Decision.—Recently the Judges of the Court of Common Pleas delivered their judgment in the case of Thomas's patent. It was argued on behalf of the defendants that the patent was bad in law—first, because there was a variance between the statement of the invention as set forth in the provisional specification and the invention as definitely described in the final or complete specification; and, secondly because the invention, as it remained described in the latter document, after giving due effect to a disclaimer which had been entered, was so large in its terms as to include machinery or instruments which were public property prior to the date of the patent. The objection as to the provisional specification was, that whereas in that document a certain instrument for holding and moving the fabric under operation was described, and then followed the words "or another acting therewith," yet in the final specification what was alleged to be the fulfilment of these statements was a presser foot for holding the cloth, which was made in two parts, the better to allow of its yielding to the movement of the cloth. The Court, composed of Chief Justice Erle, and Justices Keating, Willes, and Montague Smith, decided as to this point that it had already been adjudged (Newall *v.* Elliott, 27 L. J. Rep.) that some amount of variation from the original specification as to the specifying of the invention was to be allowed to a patentee, and they considered that if, in this case, the terms of that document were departed from, which was to be doubted, that still the variation was not great enough to be fatal, especially considering no other party had been damnified thereby. On the second point, the Court was of opinion that what was claimed under the patent was not so extensive as alleged by the defendant, for instead of the specification being properly construed by reading it as claiming "every instrument which held and moved the fabric under operation," it was confined by that document to those instruments only of the character stated as "herein described," and as the defendant had certainly infringed by adopting a mechanical equivalent for what was duly described by the patentee, who had been rightly successful and must still prevail, and the rule must be discharged.

Railways taking Land for Purposes of Third Parties.—In the case of Vane *v.* The Cockermouth, Keswick, and Penrith Railway Company, the company, whose line of railway was about to cross a lake, during the negotiations for purchase with the owner of the lake, served a notice upon an adjacent landowner to treat for a piece of land within the limits of deviation on the company's plans, the company intending to again convey the piece of land to the owner of the lake, as it would be convenient to him as a landing place for boats, &c. It was objected, on the part of the plaintiff, that as the land was not required for the purposes of the railway, the company could not take the land under the powers of their Act, which did not enable them to take land to convey it to another person. Vice-Chancellor Kindersley concurred in this view, and granted a perpetual injunction restraining the company from taking the piece of land.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

International Horticultural Exhibition and Congress, 1866.—The attention of students in drawing is especially drawn to the following prizes offered for botanical drawing:—"Water-colour drawing of any plant, British or exotic, natural size, with the usual magnified dissections; to be drawn or mounted on folio paper, and to combine scientific accuracy with artistic treatment. 1st prize, £5; 2nd prize, £3; 3rd prize, £2." Candidates will observe that these drawings must be sent to the executive committee at the Royal Horticultural Gardens, South Kensington, by the evening of Monday, the 21st of May.

Mont Cenis Tunnel.—According to assurances given by the contractors for cutting a tunnel through Mont Cenis, this international railway between France and Italy by the Alps will be open for passengers at latest in 1871, unless some accident should impede the piercing of the tunnel. The *Gazette di Genova* says:—"The piercing of one of the most important tunnels of the railroad of Eastern Liguria has just been completed; we mean the Ruta, which connects Camoglia with San Margherita by a passage of 3,050 yards. The termination of this important work does away with the most serious difficulty to the opening of the branch line from Genoa to Chiavari."

Trade of the South Wales Ports.—The following are the returns for the month of December:—

Exports of Coal.	Dec., 1865.	Dec., 1864.
Cardiff	Tons 125,521	Tons 133,560
Newport	30,145	27,393
Swansea	37,197	52,220
Llanelly	8,331	8,254
Shipments Coastwise.	**Dec. 1865.**	**Dec., 1864.**
Cardiff	Tons 59,472	Tons 61,130
Newport	40,089	46,515
Swansea	17,531	16,755
Llanelly	12,447	12,019

Cardiff also exported 8,613 tons of iron and 6,851 tons of patent fuel; Newport, 3,655 tons of iron; and Swansea, 1,309 tons of patent fuel. Of the iron exported from Cardiff, Alexandria took no less than 2,751 tons, Naples, 990 tons, and Rosario, 955 tons. Newport exported 1,470 tons to Vera Cruz, and 495 tons to New York. Not a ton of iron was cleared from Cardiff for New York. The decrease in the coal exports at Swansea and Cardiff was attributed partly to unfavourable weather and partly to the competition of railways communicating with other ports. A large quantity was also sent to Birkenhead, the Great Western tonnage rates to that port having been reduced to 6s. per ton. The mild weather caused the consumption of house coal to be below the average, and hence the decrease in the shipments, but it is expected that the past month will bear favourable comparison with the corresponding month. The patent fuel exports were principally to the Eastern markets.

Speculation in Petroleum.—During the petroleum mania in America, 1,100 oil companies were started, with an aggregate par capital of 600,000,000 dollars. It is estimated that 15 per cent. of that amount has been actually paid up, giving an aggregate of real investment of (say) 90,000,000 dollars. The production of the present year may reach about 1,500,000 barrels. The exports have usually averaged about 37 per cent. of the entire production. The average price at the well is 10 dollars a barrel, making 15,000,000 dollars as the value of the year's production. Deducting 20 per cent. for company and working expenses, this yield would leave 13½ per cent. upon the estimated 90,000,000 dollars of actual invested capital.

Coal in Africa.—At Chicova, Dr. Livingstone and his companions found a seam of coal cropping out on the banks of the Zambesi, the properties of which were explained to the natives, who, on hearing them, shook their heads, and, with an incredulous smile, replied "Kodi!" that is "Really." There was everywhere evidence of there being an immense coal field.

The Railway Coal Trade.—The coal trade in London has rapidly developed within the past few years. In 1854 the seaborne supply constituted three-fourths of the total quantity imported into the metropolis; now the railways bring, within a fraction, half the coal required for the metropolis. It appears that in the race between the railways and the coasting vessels the former are rapidly taking the lead. For the twelve months just ended the London and North-Western entered 1,093,725 tons 15 cwts. against 961,697 tons 1 cwt. for 1864; the Great Northern, 975,509 tons against 803,189 tons; the Great Western, 237,222 tons against 191,931 tons; Great Eastern, 232,501 tons 4 cwts. against 197,853 tons; Midland, 152,737 tons 1 cwt. against 137,340 tons 7 cwts.; South-Western, 19,950 tons 2 cwts. against 20,349 tons 15 cwt.; Chatham and Dover, 11,894 tons 16 cwts. against 11,744 tons 6 cwt.; South-Eastern, 8,809 tons 14 cwt. against 17,716 tons 14 cwt.; and the Tilbury and Southend 707 tons against 639 tons, making a total of 2,733,056 tons 12 cwts., against 2,342,440 tons 9 cwts. in 1864, an increase of 390,616 tons 3 cwts. The tonnage from several pits is enormous, and shows how vast is the enterprise of some of the great colliery owners in the various coal fields. The Silkstone pits, as nearly as can be calculated, forwarded to London alone (entirely independent of a large trade with almost every part of the kingdom), 214,435 tons; Clay Cross, near Chesterfield, 234,916 tons; Lambton, 91,524 tons; Pinxton, 86,352 tons; Staveley, 78,363 tons; Eckington, 76,246 tons; Codnor Park, 74,987 tons; Babbington, 72,758 tons; Riddings, 65,095 tons; Langley Mill, 58,869 tons; Shipley, 40,502 tons; Lund Hill, 32,858 tons; Gawber Hall, 28,504 tons; Plumtree, 23,659 tons; Wombwell Main, 21,571 tons; Oaks, 20,947 tons; Waidgate, 19,857 tons; Ripley, 19,876 tons; Rose Bridge, 19,337 tons; Victoria, 18,411 tons; Darfield Main, 17,237 tons; Heanor, 16,131 tons; Elsecar, 21,003 tons; Wingerworth, 14,831 tons; Parkgate, 14,077 tons; and Whittington, 13,276 tons; 52,347 tons of coke were entered.

Coal in France.—There is a great scarcity of coal in several districts of France; indeed, some works in Champagne, the Lorraine, and other parts have been stopped in consequence of not being able to procure it. Coal from the North of France has greatly increased in price at St. Dizier, and Prussian coal has been advanced fully 7d. per ton of late.

New Magnesia Light.—The Italian journals announce the discovery of a new artificial light, by Professor Carlevaris, of Genoa. The Carlevaris light is oxy-hydro-magnesian, and it is is produced by the combustion of a salt of magnesia (not a costly substance), in a mixture of oxygen, either with pure hydrogen or with common gas. The light is described as white, rich in actinic rays, steady, and giving little heat. For pothographic purposes it is said to be excellent. The light is said not to be affected by currents of air, and to be extremely cheap; a light equal to four composition candles is set down at two centimes, or less than a farthing per hour. An experiment was tried at the lighthouse of Genoa. The new light is reported to have proved superior to that of the ordinary lamps in use there, which represents 23 Carcel lamps, and to have cost not more than 3d. an hour.

Magnesium in America.—As might have been prognosticated, the Americans have not been slow to convert the magnesium light to public service. In their theatres it is superseding the lime light. It was first introduced at the Boston Theatre. The wire is burnt in a large lamp, and delivered by clockwork. The flame sustains itself continuously from an hour and a half to two hours, in which time from ¾ oz. to 1½ oz. of metal is consumed. The fumes are arrested within the lamp by mechanical means, and thus the reflector and the glass in front are preserved from fouling. Although the lamp costs 100 dols., the maker finds it difficult to meet the orders he receives for it. An American magnesium company has commenced operations at Boston.

Plans by Photography.—It is announced in Paris that the optician Chevalier has succeeded in arranging an apparatus for taking geometric plans by photography. According to the "Society of Arts' Journal," the instrument is provided with a meridional telescope, and a compass in order to set it to any given point; a circular collodionised glass is placed horizontally at the bottom of a camera obscura, formed of copper, and moved by clock-work, so as to describe within a given time the entire circle of which the station chosen is the centre, and the various objects as they are received in turn by the lens are photographed on the circular plate through an extremely narrow slit in the side of the copper box. The operation is to be repeated at three stations in order to avoid error, and the result is said to be highly satisfactory. The three circular plates are then used to lay down on paper all the points of the plan described. The same instrument working vertically, instead of horizonally, serves also for levelling.

Royal Naval Reserve.—The report of the Registrar-General of Seamen and Shipping on the Royal Naval Reserve for the last month states that up to the 30th of December, 1865, 22,852 applications have been received, and 19,796 volunteers enrolled in the under-mentioned ports:—Aberdeen, 645; Aberystwith, 19; Alloa, 45; Arbroath, 54; Ardrossan, 56; Arundel, 4; Ayr, 5; Banff, 28; Barnstaple, 19; Beaumaris, 21; Belfast, 68; Berwick, 48; Bideford, 33; Blyth, 86; Borrowstoness, 20; Boston, 3; Bridgwater, 210; Bridport, 28; Bristol, 1,003; Carnarvon, 126; Cardiff, 126; Cardigan, 31; Carlisle, 5; Colchester, 8; Cork, 200; Cowes, 4; Dartmouth, 259; Deal, 4; Douglas, 48; Dublin, 117; Dumfries, 5; Dundalk, 1; Dundee, 1,014; Exeter, 190; Falmouth, 88; Faversham, 31; Fleetwood, 30; Folkstone, 1; Fowey, 183; Galway, 29; Glasgow, 372; Gloucester, 1; Grangemouth, 6; Greenock, 154; Grimsby, 14; Guernsey, 2; Hartlepool, 702; Harwich, 19; Hull, 191; Inverness, 67; Ipswich, 12; Kirkwall, 3; Leith, 101; Lerwick, 222; Limerick, 26; Liverpool, 1,693; Llanelly, 33; London, 4,543; Londonderry, 2; Lowestoft, 21; Lyme, 21; Lynn, 80, Maldon, 10; Maryport, 145; Middlesborough, 9; Milford, 35; Montrose, 76; Newcastle, 266; Newhaven, 39; Newport, 6; Newry, 4; Padstow, 4; Penzance, 85; Perth, 10; Peterhead, 229; Plymouth, 401; Poole, 118; Portsmouth, 93; Preston, 1: Ramsay, 4; Ramsgate, 14; Rochester, 19; Runcorn, 9; Rye, 22; Scarborough, 36; Seaham, 504; Shields (North), 1, 95; Shields (South), 456; Shoreham, 11; Sligo, 3; Southampton, 346; Stornoway, 1; Strangford, 2; Stranraer, 4; Sunderland, 1,497; Swansea, 204; Teignmouth, 25; Tralee, 2; Troon, 1; Waterford, 28; Wells, 3; Wexford, 56; Weymouth, 39; Whitby, 15; Whitehaven, 147; Wick, 1; Wisbeach, 3; Workington, 16; Woodbridge, 4; and Yarmouth, 108. If there is deducted for men who have joined the Royal Navy, 396; been discharged, 678; died, 1,185; not applied to be re-enrolled, 541; in all, 2,800. The present strength of the Reserve is reduced to 16,966. Of the above, 49 possess certificates of competency as masters, 898 certificates of competency as mates, 19 certificates of service as masters, and 61 certificates of service as mates. The total is 1,027. The force also includes 2,787 petty officers in the merchant service.

War Statistics of the United States.—During the war, says an American paper, the United States' Government had at its command 40,000 miles of railroad; 15,000 miles of telegraph were abandoned, torn down, and reconstructed. The Etowah bridge, 625ft. long and 75ft. high, was built in six days, and the Chattahoochee bridge, 740ft. long and 90ft. high, was built in four days. There were 214,102 horses and 58,818 mules in Grant's army, their cost for keep being 1,000,000 dols. monthly. During the war the horses and mules of the army consumed 23,000,000 bushels of corn, 79,000000 bushels of oats, 1,500,000 tons of hay, and 21,000 tons of straw, which cost 155,000,000 dols. During the last year of the war 105,019,406 dols. were paid for clothing and equipage including 400,000 jackets, 3,000,000 pairs of drawers, trowsers, and flannel shirts, and 1,746,034 woollen blankets, 1,000,000 canteens, 6,000,000 pairs of socks, 2,000,000 knapsacks, 10,000 flags, 1,400 fifes, 4,000 bugles, and 16,000 drums.

The Paris Exhibition Building.—The *Moniteur* publishes regularly the state of the works at the Champ de Mars, for the Exhibition of 1867. The progress is very favourable, and there is every reason to expect that the earthwork and masonry contractors will have completed their contracts before the specified time. On the 15th ult. the cube of the embankment amounted to 80,000 metres, and that of the foundations to 100,000 metres. The total earthworks for obtaining a level site for the building and levelling the Champ de Mars are consequently 180,000 cubic metres up to the above date. More than half the masonry for the foundations, the sewers, and subterranean ventillation channels were executed. The cube of the masonry completed up to the 15th ult. is 160,000 metres. The lower pieces of the metal framework are beginning to be laid, and towards the end of the present month, the first of the metallic arches, which are to form portion of the monumental part of the building, will be put in place.

The Patent Office Inquiry.—A final report by Messrs. Greenwood and Hindmarsh to the Lord Chancellor in reference to the Patent Office has been issued. They recommend that the office of Clerk of the Patents be abolished, and that a superintending officer, with a salary of not less than £1,500, be appointed. They think the clerks generally are underpaid, and they recommend that the staff in the specifications department be increased. "It is very desirable," says the report, "that persons who occasion extra work to be done in the office should be made to bear the expense. The only remedy which seems to us to be available in the present state of the law is for the commissioners to make a regulation that persons filing specifications shall pay the expense of correcting their inaccurate copies, and upon leaving their specifications shall deposit sums of money by way of security." The expediency or necessity for the extension of the Patent Office Museum is believed by the reporters to be an idea entertained by many of the most eminent perrsons, both in town and country, as well as by the scientific gentlemen who

have already presented a memorial on the subject. The museum, ought, the commissioners think, to be in the same building as the Patent office. (It has been exhibited hitherto in South Kensington.)

Breakages at Ironworks.—During 1865 serious losses have been sustained by masters and men, throughout South Staffordshire in particular, by stoppages consequent upon the breakages of machinery at the finished ironworks. To so great an extent has this loss prevailed in one case, that a number of the men employed at one of the works of a leading finished iron firm in South Staffordshire have, chiefly through it and the eight or ten weeks' play which occurred on the occasion of the strike and the lock-out, made only half time upon the average of the year. These losses need not, however, take place in other than rare instances. They arise out of a desire to conduct the works economically, but the result is the very opposite. Ironmasters who have tolerably good foundaries are fond of making most of the heavy castings to be laid down in their mills and forges, but the skill which they have usually at their control is insufficient to produce more than a portion of the castings required, and those the less important. The very best iron that can be obtained for mixtures cannot, of course, turn out wheels which, moving a forge and mill train, will work one into the other with an exactness which is desirable to prolonged and easy wear. To make up for the absence of perfect exactness, an amount of play is not unfrequently allowed which is most destructive to smoothness, a jolting being the result, which, increased when the iron is in the rolls, becomes whilst the iron is passing through, in many cases, only a little short of a deafening rumble. This state of things is the less excusable because in most iron-making districts, and in South Staffordshire in particular, there are firms whose peculiar business it is to turn out heavy castings of this description. Some time ago, Messrs. Jackson, the well known machinists of Manchester, patented a process for making sets of driving toothed wheels by machinery. Very recently a firm in South Staffordshire have "provisionally specified" a process for making, also by machinery, wheels of this class but of a much more massive description than that produced by Messrs. Jackson. Wheels made upon this plan, and used in the forges and mills of ironworks, revolve with the smoothness and precision never observable in the machinery turned out upon the old plan, and also with an absence of noise, whether the iron is under the rolls or not, which is perfectly delightful to observe. As yet only one set have been laid down. They have just been put into operation at a small works in South Staffordshire, where tin-pletes are manufactured. The driving wheel is 16ft. diameter, and weighs upwards of 20 tons: it drives the spur and other wheels working a forge lever-hammer, and an 18in. forge train, all of which have been supplied by the makers of the wheels. The engine is a 60 horse-power, with a 7ft. stroke, and of the beam condensing principle.

NAVAL ENGINEERING.

Tenders for Armour Plates.—The Lords of the Admiralty have accepted the tender of Messrs. John Brown and Co., of the Atlas Iron and Steel Works, Sheffield, for the manufacture of rolled armour-plates of 8in. and 9in. in thickness for the new iron-clad frigate *Hercules*, about being commenced at Chatham Dockyard. An order received at Chatham also states that their Lordships have likewise accepted the tender of Messrs. Cammel and Co., of the Cyclops Works, as well as that of the Mersey Iron Company, for the manufacture of the 6in. plates required for the *Hercules*. The contract price to be paid for the 8in. and 9in. plates is £33 per ton, and for the 6in. plates £29 10s. and £29 5s. per ton.

Rodger's Anchors.—The anchors received at Woolwich from the Northfield Iron and Steel Works at Rotherham, and manufactured on Captain Rodger's indented small palm principle, have been submitted to a severe test under the hydraulic press. The last was proved on the 10th ult. in the presence of the authorities of the yard. They are intended for service on board the Indian transport vessel *Crocodile*, and all endured a strain of 50 per cent. higher than that prescribed by the Admiralty regulations. The elongation of the arms, or the greatest variation of angle, when the strain was on, was five-eighths of an inch, and when the machinery was slackened, they regained their usual form, showing no permanent set, which was highly satisfactory. Before their removal from Rotherham the anchors were fire tested in the presence of one of the foremen smiths sent down from Woolwich for that purpose. The test is consequently completed, and they will be retained in the yard until the completion of the *Crocodile* for sea.

The "Malacca," 17, screw corvette, made her official trial of speed on the 3rd ult., at the measured mile in Stokes Bay, under the supervision of the officers of the steam factory and reserve of Portsmouth Dockyard. The ship was down to her lead-line draught, having officers and crew, with all stores, on board. She drew 15ft. 10in. of water forward, and 18ft. aft. The wind was moderate during the trial, and the sea smooth, the six runs being made over the mile with the following general results:—Ship's speed, first run, 9·724 knots; second, 9·375; third, 9·677; fourth, 9·376; fifth, 10·112; sixth, 8·847 knots. The mean measured mile speed of the ship was 9·576 knots. The maximum number of revolutions, 92, the pressure of steam, 20lb., and the vacuum 27in. forward and aft. In trying her turning powers, the ship completed her course each time as follows:—With full-boiler power—Half circles, to port, 2 min. 35 sec.; to starboard, 2 min. 27 sec. Full circles—To port, 5 min. 2 sec.; to starboard, 5 min. 20 sec. Revolutions—Before entering circle, 92; after ditto, 86. With half-boiler power—Half circles, to port, 2 min. 56 sec.; to starboard, 3 min. 6 sec. Full circles—To port, 5 min. 50 sec; to starboard, 6 min. 20 sec. Revolutions of engines—Before entering circle, 91; afterwards, 87. The *Malacca* is of 1,034 tons, and her engines are 200 horse-power, nominal, driving a Griffith's two bladed screw. The trial of the ship's machinery gave full satisfaction.

Martin's Anchor.—Mr. Martin, of the mercantile navy, has at last succeeded in bringing before the notice of the Lords of the Admiralty a new self-canting anchor, which recently sustained a very severe proof under the hydraulic testing gear in Woolwich dockyard. It possesses considerable holding power and strength, combined with diminished weight, and it can neither foul nor become fouled. Nor can the vessel's bottom be injured by it, as no part of it projects above the ground. The anchor, which was recently tested, is intended for Her Majesty's iron gunboat *Vixen*, now fitting in the basin at that yard for service. Two other anchors on the same principle—bower and sheet anchors, one weighing 55cwt.—are now lying at Woolwich for the iron-cased corvette *Favorite* and the double-screw gunboat *Viper*, in course of construction at Poplar. The anchor is exceedingly short in the shank—namely, 79in., and is of malleable iron, without welding. The weight of the anchor is 21cwt. 3qrs. 14lb. It was manufactured at the Gateshead Ironworks under the immediate superintendence of the patentee. Having borne the full Admiralty test of 21 tons 13cwt. 1qr., without the slightest permanent deflection, Mr. Martin, who was present, suggested an increase of 50 per cent. This strain was applied in double position to each arm, working up to 32 tons 15cwt. The deflection was then 5-16ths of an inch.

The "Salamis," 2, paddle-wheel despatch vessel, was tried over the measured mile in Stoke's Bay, on the 26th ult., in accordance with the Admiralty regulations for ascertaining the speed of all Her Majesty's ships prior to their departure on foreign service. The *Salamis* drew 10ft. 1in. of water forward, and 10ft. 4in. aft, having six mouths' stores in her hold, and 166 tons of coals in her bunkers, and being in all respects complete and ready for sea. Six runs were made with full-boiler power, the respective speed of each run made being 12.721, 14.063, 13.091, 14.342, 13.091, and 14.402 knots; the mean speed of the ship at full boiler-power, 13.649 knots; steam pressure, 25lb. Vacuum—forward engine, 25in.; after engine, 26.5. Revolutions of the engine—maximum, 32; minimum, 31. With half-boiler power four runs were made over the mile, with the following speeds —10.434, 12.203, 10.055, and 12.203 knots, the mean speed at half power of the ship being fixed by these figures at 11.224 knots. In trying the turning powers of the ship, by making circles to port and starboard, the following general results were arrived at:—With full power, to port, the half-circle was made in 2 min. 46 sec., and the full circle in 5 min. 2 sec., the times respectively in turning to starboard being 2 min. 38 sec. and 5 min. 5 sec.; with half-boiler power the circle was made to port in 6 min. 16 sec., and to starboard in 5 min. 59 sec. The trial gave every satisfaction. The engines of the ship are by Messrs. Ravenhill, Hodgson, and Co., and are of 250 horse-power, nominal.

The Screw Steam Sloop "Amazon," 4, on the 12th ult., went outside Plymouth Breakwater to test her engines and machinery. The manufacturers of the engines, Messrs. Ravenhill and Co., were represented by Mr. Richard Hodgson, one of the principal partners. The wind was northerly, force about 3, with a slight swell. The *Amazon* on this occasion drew 13ft. 4½in. forward, and 16ft. 4½in. aft, and the four-bladed screw previously used was displaced for a two-bladed Griffith's, having a diameter of 15ft. and a pitch of 15ft. Six trials under the full-boiler power produced a mean of 12·171 knots, the mean revolutions being 88½. Four trials under half-boiler power produced a mean of 10·461 knots; the revolutions were 72. The pressure of steam on the engines was 25lb., and the vacuum 25½in. She went round the circle (·35 of a mile) in 3 min. 28 sec., and answered her helm very well. Throughout the day the engines worked satisfactorily, and there were no hot bearings. The sloop measures 1,081 tons, is 187ft. long, and 32ft. broad. At the former trial her draught was 13ft. 3in. forward, and 16ft. 4in. aft. After four runs the results were:—Mean speed, 11·492; speed of the screw, 11·100; negative slip, ·392; and revolutions, 75.

The Vixen, a new double screw iron and wood gunboat of 754 tons burden, and engines of 160 horse-power, built by Mr. Charles Langley, at the Deptford-green Dockyard, has arrived at Woolwich to be fitted out for service. She is constructed at a cost of £20,000, and is according to the improved modern principle introduced by Mr. Reed. She has a powerful prow, which will be a most formidable weapon of attack, submerged similarly to that of the *Pallas*. She is appropriately named the *Vixen*, and will carry four guns—two of heavy calibre, and two lighter guns for boat purposes. The *Vixen's* principal dimensions are as follows:—Length between perpendiculars, 160ft.; breadth, 32ft. 5in.; depth of hold, 13ft. 7in.; builders' tonnage, 737 31·94. The engines are supplied by Messrs. Maudslay, Son, and Field. On her arrival yesterday at Woolwich she was taken in charge by Captain Dillon, of the Steam Reserve, and was received on behalf of the Admiralty.

300-Pounder Armstrong.—The following are the proportions of shot and shell to be supplied for each of the 12½ ton 300-pounder Armstrong guns, with which the *Bellerophon*, 14, 1,000 horse-power, fitting at Chatham, is to be furnished—viz., empty shells, 15 common, five double elongated, and five segment, the number and character of the filled shells being the same. The solid shot for each gun will consist of 20 cwt. of chilled shot, and ten steel spherical shot.

The French Navy.—The Report of the Minister of Marine contained in the blue book gives the following interesting details on the construction and reconstruction of the French navy.—During the year 1865 the building of the vessels of the new fleet has been continued within the limits of the allotted grants. It has been found necessary to complete the plan adopted in 1857, by new types of iron-clad vessels more specially appropriate, some for distant service, others for the defence of harbours, roadsteads, and the mouths of rivers. Two of these ships of war have been created—an iron-cased corvette and a ram—for coast defence. The new fleet which (exclusive of gun-boats) numbered 123 vessels on Dec. 31st, 1864, on the 31st Dec., 1865, numbered 129, viz.:—

	Vessels of High Speed.		Auxiliary Screw Ships.		Totals.
Ironclad frigates	10	...	—	...	10
Ironclad corvette	1	...	—	...	1
Ironclad coast-guard ram	1	...	—	...	1
Ships not iron-cased	13	...	23	...	36
Frigates not iron-cased	18	...	6	...	24
Corvettes ditto	11	...	—	...	11
Dispatch boats ditto	46	...	—	...	46
Totals	100		29		129

Thus the renovated navy has increased by six vessels fully completed:—Three iron-cased frigates of 1,000 horse-power; one iron-cased corvette of 500 horse-power; one iron-cased coast-guard of 500 horse-power; one corvette not iron-cased of 500 horse-power. There are, in addition, 28 steam ships on the stocks in various stages of progress. The navy is just now using French coal, which by the French papers is stated to be an immense political as well as commercial advantage.

Naval Appointments.—The following appointments have taken place since our last:—F. Hallett, first-class assist.-engineer, to the *Medusa*, vice Pugh; R. Widdecombe. W. P. Ward, J. G. Bain, T. Barker, H. J. Wilson, T. Cross, and J. Phillips, promoted to be engineers; J. Miller (a), and A. Smart, promoted to be acting engineers; J. Shore, promoted to be first-class assist.-engineer; W. H. Roberts, engineer to the *Megæra*, vice Luiger, to the *Fisgard*, as supernumerary; J. Bruce (b), chief engineer, to the *Star*, commissioned; J. H. Brettell, engineer, to the *Star*, commissioned; T. S. Nunn, engineer, additional, to the *Cumberland*, for service in the *Recruit*; A. T. V. Forster, first-class assist.-engineer, to the *Star*, commissioned.

MILITARY ENGINEERING.

Artillery Experiments.—Major Palliser's two 68-pounders converted into 7in. rifled guns have recently fired 50 rounds each, with the severe charges of 22lb. of powder and 115lb. shot, at Shoeburyness, and have stood the test perfectly. The following is the history of one of these guns:—First, 373 rounds as a smooth-bore 68-pounder, unserviceable; secondly, converted by Major Palliser into 7in. 100-pounder, 750 rounds, as follows—20 rounds of 12lb., 40 of 20lb., and 690 of 16lb. charges, and shot of 100lb.; inner tube split, 50 rounds of 16lb. charge and 100lb. shot, to see whether the gun would burst, which it did not. The gun was repaired, and is now as good as ever. The shooting of both guns was excellent; the range at 10 degs. was 4,450 yards, the mean difference of range about 21 yards, and mean deflection 3 1-5 yards. We are informed that several guns are at present being prepared by the Elswick Ordnance Company on Major Palliser's plans. Four of these are cast-iron 32-pounders converted into rifled 64-pounders, and four are 24-pounders converted into rifled 56-pounders. They will be issued in pairs to various stations, from which reports will be sent in of their performances. Their charges will be 7lb. and 6lb. of powder, and they will throw shells with large bursting charges. The late trial of the 600-pounder *v.* the Hercules target resulted, it is stated, in favour of the chilled cast-iron shot.

STEAM SHIPPING.

Iron Shipbuilding on the Humber.—The returns of the ships built and launched from the two iron shipbuilding yards on the Humber, near Hull, have just been issued. The total registered tonnage of the ships amounts to 19,396. Of these, vessels with a tonnage of 9,882 tons were launched from the yard of the Humber Iron Works and Shipbuilding Company; the remaining vessels, of 9,514 tons, were turned out by Messrs.

C. and W. Earle. The vessels built by the Humber Company consisted of six large sailing ships and five steamers. Four of the sailing ships, which were for Liverpool houses, were each upwards of 1,300 tons register. In 1864 this Company built five sailing ships and four steamers, with a gross registered tonnage of 7,821, thus showing an increase of tonnage in the year of upwards of 2,090 tons. During 1865 Messrs. Earle built eight steamers, with a tonnage of 9,514, and a steam power of 980 horses. In 1864 Messrs. Earle built six steamers and two sailing ships, with a tonnage of 9,479. Of the vessels built by the firm in 1865 two were of more than 2,300 tons, and two of more than 1,300. The two largest were built for Messrs. J. Moss and Co., for the East India trade. Two vessels have been built on the Humber for the Manchester, Sheffield, and Lincolnshire Railway Company—the first under the powers of the Steamboats Bill obtained last Session by that company. One of them, the *Lincoln*, 667 tons register, was built by the Humber Company, and the other, the *Wakefield*, also 667 tons register, was built by Messrs. Earle. These vessels will ply between Grimsby and Hamburg. Two other steamers for the same company, the *Leeds* and the *Bradford*, have been built on the Clyde, to run between Grimsby and Rotterdam.

Steam Shipbuilding on the Clyde.—At the commencement of the current year the following firms had each more than 5,000 tons of new steam shipping on hand:—Messrs. Barclay, Carle, and Co., 11,380 tons; Messrs. Connell, Charles, and Co., 6,870 tons; Messrs. Caird and Co., 9,620 tons; Messrs. Denny, Brothers, 7,620 tons; the London and Glasgow Engineering and Iron Shipbuilding Company (Limited), 9,380 tons; Messrs. R. Napier and Son, 5,910 tons; Messrs. Randolph, Elder, and Co., 12,400 tons; Messrs. A. Stephen and Sons, 6,130 tons; Messrs. R. Steele and Co., 6,450 tons; and Messrs. J. and G. Thompson, 7,390 tons. Messrs. T. Wingate and Co., of Whiteinch, have launched a paddle named the *Murray*, of 313 tons, builders' measurement, fitted with oscillating engines of 60 horse-power. The *Murray* has been built to the order of Captain Johnston, for the Australian coasting trade. She is bark-rigged, and is intended to go out under canvas. Messrs. Kirkpatrick, M'Intyre, and Co., of Port Glasgow, have launched a screw of 214 tons, builders' measurement. Her dimensions are 120ft. by 19ft. and 9ft. 6in., and she will be fitted by Messrs. W. Simous and Co., of Renfrew, with a pair of direct acting condensing engines of 40 horse-power nominal.

Iron Shipbuilding in South Wales.—The iron shipbuilding trade has of late become an important addition to the prosperity of South Wales. It was not till recently this comparatively new branch in the maritime art was introduced inro this district, and since then great progress has been made at the several ports where iron shipbuilding yards have been established. It has been proved beyond a doubt that the district is capable of producing iron plates suitable for first-class ships, and that in the course of a few years the principality will be a strong competitor with the North of England in the building of iron vessels. In addition to the ships already launched, a fine iron barque has just left the stocks of Messrs. Batchelor Brothers' yard, Cardiff. The barque is the property of Messrs. Cory, of Cardiff, and is destined for the copper ore trade. Her length is 140ft.: breadth of beam, 24ft.; depth of hold, 17ft. A large iron vessel is about being built at the East Yard, Newport, by Mr. Spittle, and there are also iron ships on the stocks at Cardiff and Llanelly. This indicates that the advantages of the district for iron shipbuilding are being gradually appreciated by the capitalists.

Steam Navigation in Russia.—The Russians are rapidly covering their seas and large rivers with steam vessels, mostly built in this country. Messrs. C. Mitchell and Co., of Low Walker, on the Tyne, have just received an order to build two screw steamers of 500 tons each, for the navigation of the Caspian Sea, to which sea these vessels will sail direct from this country. The same firm are also about to build two more powerful steamships for the Russian Steam Navigation Company, and intended for their fleet on the Black Sea, trading with the Crimea. They will be fitted up to carry a large number of passengers, and they will be supplied with engines by Messrs. Penn and Son, of London, with all the modern improvements for economy of fuel.

TELEGRAPHIC ENGINEERING.

The Telegraph in different Countries.—At a recent meeting of the members of the Liverpool Historic Society a paper was read by Mr. E. B. Bright, C.E., on this subject, in the course of which he stated that in the world there were 86,600 miles of telegraph line, carrying very nearly 250,000 miles of wire. In England there were 16,148 miles of line, and 73,810 miles of telegraph wires; so that, as to the length of line, England returned between one-fifth and one-sixth of the whole of the telegraphs of the world; and as to the length of wires, it was between one-third and one-fourth. The English rate of charge, after that of France and Switzerland, was the lowest in the world. In America the rates were exceptionally high, and consequently the signal company there realised exceptionally large profits. A great part of the telegraph abroad was worked for political purposes, and was kept in the hands of the Government for that reason, and it was not worked on a commercial basis at all. In France there was formerly a loss of £130,000 to £140,000 a year on the working of the telegraph, and last year there was a loss of £40,000. In India the last returns showed a loss of £70,000 on the year in the working of the telegraph, and that notwithstanding that the rate for transmitting messages in India was higher than it was in England. It had been asserted that the rate system for the transmission of telegrams might be made to assimilate to the postal system: but it must be borne in mind that letters from one town to another could be conveyed in the same train, whereas, if even one firm had to transmit twenty messages, those messages would have to be transmitted separately, and taken separately to the persons to whom they were addeessed.

RAILWAYS.

Railway Carriages.—Mr. Rock Chidley has recently brought out an invention for improvements in railway carriages, which consists mainly of affording easy means of communication through the whole of the carriages of a train, and an economical mode of warming and ventilating them. For the same object the inventor proposes an opening at the end of each carriage, the connection being made by means of a covered or hooded platform, constructed so as to expand, if required, from a space of a few inches to one of several feet. The object is to give the guard of the train an easy means of communicating with any of the passengers. Below the flooring (which is perforated) of each carriage a serpentine pipe is placed, and the pipes below adjoining carriages being connected, they can be supplied with steam from the engine for the purpose of warming. Provisions for a safety valve and self acting taps for the discharge of the condensed water have been made. Ventilation is accelerated by admitting the air through the perforated flooring required for the warming, and by an air passage between the top of the compartments and the roof of the carriage, on which latter are set ventilators, having a cowl above to turn with the wind.

Indian Railways in 1865.—At Midsummer, 1865, the number of miles of railway opened for traffic in India, was $3,186\frac{1}{4}$, and the length remaining to be finished, $1,730\frac{1}{4}$, making a total of $4,916\frac{1}{2}$ miles, consequently, about two-thirds of the lines sanctioned by Government are finished. Of the ten Indian railways and their branches, the following number of miles are open for traffic:—East Indian, 1,126; Great Indian Peninsula, $595\frac{1}{4}$; Madras, 571; Bombay, Baroda, and Central India, 306; Scinde, 114; Punjab, 252; Punjab Delhi, none; Eastern Bengal, 114; Great Southern, 79; Calcutta and South Eastern, 29; total, $3,186\frac{1}{4}$. The miles of the sanctioned lines yet to be finished and opened are:—East Indian, $370\frac{1}{2}$; Great Indian Peninsula, $670\frac{3}{4}$; Madras, 281; Bombay, Baroda, and Central India, 6; Scinde, none; Punjab, none; Punjab Delhi, 320; Eastern Bengal, none; Great Southern, 82; Calcutta and South Eastern, none; total, $1,730\frac{1}{4}$. The capital expended for rolling stock since the first Indian line was commenced up to the 1st May, 1865, was £54,912,029, the expenditure during the past year only being £3,806,044, of which about £2,418,345 were spent in India, and £1,387,699 in England. To meet this expenditure 36,533 shareholders subscribed up to December the 31st, 1864, £58,000,000. Of these shareholders 29,303 were registered in England, and 777 in India, 393 only of the whole being natives. The rate at which capital has been expended upon Indian railways during the past fifteen years, is shown by the following figures:—In 1850, £175,156; 1851, £351,323; 1852, £427,560; 1853, £670,649; 1854, £1,729,588; 1855, £3,371,005; 1856, £3,517,907; 1857, £3,417,268; 1858, £5,491,125; 1859, £7,162,872; 1860, £7,589,770; 1861, £6,558,614; 1862, £5,810,852; 1863, £4,771,775; and 1864, £3,806,044. The cost per mile of Indian railways, if completed according to estimate, will be as follows, notwithstanding the expense of transporting men and materials to India:—East Indian, £20,849; Bombay, Baroda, and Central India, £19,230; Delhi, £18,750; Scinde, £17,543; Eastern Bengal, £15,789; East Indian (Jubbulpore), £15,555; Great Indian Peninsula, £12,646; Madras, N.W. line, £12,500; Punjab, £11,857; Madras, S.W. line, £11,178; and Great Southern, £9,316. The average cost per mile of English railways, including purchase of land, is £33,350. The fares on the Indian railways vary as follows:—First class, from $1\frac{1}{4}$d. per mile on the Scinde Railway, to 1 4-5d. on the Bombay and Baroda. Second class, from $\frac{5}{8}$d. on the Madras Railway to 1d. on the Great Indian Peninsula, and several others. Third class, from $\frac{1}{2}$d. to $\frac{3}{4}$d., half the lines charging the one amount, and half the other. There is a fourth class at $\frac{3}{8}$d. per mile, on the East Indian, Eastern Bengal, and Calcutta and South Eastern Railways. The quantity of materials sent out in 1854 for the construction, maintenance, and working of railways in India, amounted to 102,318 tons, in 233 ships. The value of the goods shipped was £1,018,164, and the amount paid for freight and insurance, £164,528.

The Number of Miles of Railway, single and double, open for traffic in the United Kingdom on the 31st December, 1864, was 12,789 miles, being an increase of 467 miles as compared with 1863. Of these lines, England and Wales have 8,890 miles; Scotland, 2,105 miles; and Ireland, 1,794 miles. The total authorised capital for the construction of these works to 31st December last was £390,413,137 by shares, and £130,109,197 by loans; in all, £520,522,334. Nearly five millions of trains were run in the year, the exact number being 3,106,651 passenger, and 1,863,318 goods trains, being an increase of 188,991 passenger, and 105,285 goods trains, or of 294,276 trains in all, or of above an average of 800 trains per day, Sundays inclusive. The trains ran 129,130,943 miles. The passengers carried in the year were 229,272,165, exclusive of 76,499 periodical ticket holders, of whom there was an increase in the year of 12,108. The main increase was, in the third class, 15,229,183; increase in second class, 7,792,500; in first class, 1,615,407. As relates to second-class passengers in Scotland, there is a decrease of 101,764. The number of cattle carried in the United Kingdom was less by 161,714 heads. In Ireland the falling-off was greatest, the decrease being—in cattle, 101,026; sheep, 41,930; pigs, 37,786. There was an increase of 7,402,627 tons in the coal and other minerals carried; and of 2,397,666 tons of general merchandise. The total receipts for passenger traffic was £15,684,010, being an increase of £1,162,512. The receipts from goods traffic was £18,331,524, being an increase of £1,696,655. Total gross receipts, £34,015,564; increase, £2,859,167. With three more sessions of Parliament such as that of the year 1865, the authorised capital of the railways of Great Britain will equal in amount the funded debt of the empire.

Proposed Pneumatic Railway at Brighton.—A subject of discussion in the Brighton Town Council has been the projected formation of a pneumatic railway into the middle of the town, at a depth of 28ft. or 30ft. from the surface, so as to be clear of the drainage, actual or prospective.

The Carriage-works of the Great Western Railway Company.—Cripling Meadow, at Oxford, has been conveyed to the Great Western Railway Company by the corporation, and all that remains now to be done is the making of an application by the company for additional powers to enable them to purchase a few acres of adjoining land. Against that application neither the University nor City authorities have signified any intention of opposition, as the transfer of a larger area will be mutually beneficial.

Estimated Cost of the New Works of the North-Eastern Railway.—It appears from the documents deposited at the Private Bill Office that the North-Eastern new lines and works are estimated by Mr. Harrison at £392,600 of which the new station at York will cost £48,674 18s. 6d.. and the land to be purchased will cost £48,674. The company's new lines and works in the county of Durham will be constructed on Mr. Harrison's estimate, for the sum of £128,500. The necessary bridges are computed to cost £30,512, independent of the lock and bridge over it at the timber pond, Hartlepool Slake, which will absorb £2,400. The land and buildings will be acquired for the sum of £19,895.

DOCKS, HARBOURS, BRIDGES.

Proposed Wet Dock at Whitehaven.—At a recent meeting of Whitehaven trustees Dr. Fidler took up his notice of motion pledging the trustees to obtain a wet dock. He passed rapidly in review the attempts which had been made to get a wet dock since 1854. He then proposed a motion in the terms of the notice. Messrs. Jefferson, J. Lindow, and Thompson, spoke in favour of a wet dock; Mr. Lindow producing a plan for a dock in the neighbourhood of Kennedy's yard, which he believed might be constructed for £70,000 or £80,000. The motion was carried. Dr. Fidler then took up his other motion, that Mr. Coode, C.E., be requested to confer with this Board as to the practicability of constructing a dock at a cost of £120,000. After some discussion, in which it was decided that the words "for £120,000" should be struck out, and it was stated that if a sum was named Mr. Coode would think himself at perfect liberty to expend that sum, the motion was carried.

APPLIED CHEMISTRY.

Detection of Antimony in Tube Sublimates.—In the examination of mineral bodies for antimony, the test substance is often roasted in an open tube for the production of a white sublimate. The presence of antimony in this substance may be detected by the following process—a method more especially available when the operator has only a portable blowpipe-case at his command—The portion of the tube to which the chief part of the sublimate is attached is to be cut off by a triangular file, and dropped into a test tube containing some tartaric acid dissolved in water. This being warmed or gently boiled, a part at least of the sublimate will be dissolved. Some bisulphate of potash—either alone, or mixed with some carb.-soda and a little borax, the latter to prevent absorption—is then to be fused on charcoal in a reducing flame; and the alkaline sulphide thus produced is to be removed by the point of the knife-blade, and placed in a small porcelain capsule. The hepatic mass is most easily separated from the charcoal by removing it before it has time to solidify. Some of the tartaric acid solution is then to be dropped upon it, when the well known orange-coloured precipitate of SbS_3 will at once result. In performing this test, it is as well to employ a somewhat large fragment of the test substance, so as to obtain a thick deposit in the tube. It is advisable also to hold the tube in not too inclined a position, in order to let but a moderate current of air pass through it; and care must be taken not to expose the sublimate to the action of the flame, otherwise it might be converted almost wholly into a compound of SbO_3 and SbO_5, the greater part of which would remain undissolved in the tartaric acid solid. A sublimate of arsenious acid, treated in this manner, would, of course, yield a yellow precipitate, easily distinguishable by its colour, however, from the deep orange antimonial sulphide. The crystalline character, &c., of this sublimate would also effectually prevent any chance of misconception.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF THE ARTIZAN."

DATED DECEMBER 23rd, 1865.

3333 C. W. Moore—Valves
3334 G. Horn and D. Horn—Obtaining continuous lengths of tanned leather
3335 W. Gill and B. Bird—Affixing postage and other adhesive stamps

DATED DECEMBER 26th, 1865.

3336 E. Lones, J. C Lones, J. Lones, J. Brettle, T. Brettle, and C. Vernon—Axles
3337 C. Reeves—Breech-loading fire-arms and cartridges for same
3338 J. Fisher—Steam boilers
3339 W. F. Deane—Applying copper to ships' sides and bottoms
3340 M. Henry—Soda
3341 C. J. Viehoff and J. A. Matthiessen—Steering indicators
3342 J. Rea—Lubricating machinery

DATED DECEMBER 27th, 1865.

3343 J. Benn and G. O. Luckman—Damping and gumming labels
3344 G. C A. Marquis d'Auxy—Preserving grain and ores
3345 J. Young—Treating hydrocarbon oils
3346 S. Griffith—Paying out and hauling in telegraph cables
3347 H. A. Silver—Electric conductors insulated with india rubber
3348 W. C. Dodge—Breech-loading fire-arms
3349 J. H. Lester—Lubricating oil
3350 N. W. Wheeler—Duplex steam engines
3351 N. W. Wheeler—Relieving distilled and other liquids from gases mechanically mixed therewith

DATED DECEMBER 28th, 1865.

3352 N. W. Wheeler—Sea-going vessels
3353 J. Bates, E. Brookes, and E W. Brookes—Piston and grease cup
3354 F. T. Hubert—General electric typ-o-printo-telegraphic machines
3355 E. V. Gardner, L. A. Israel, and H. A. Israel—Disinfecting compounds
3356 S. and C. Collins—Machinery used in tearing silk
3357 C. F. Varley—Telegraphic cables
3358 R. A Brooman—Obtaining motive power
3359 E. Oppenheim—Indian fire
3360 C. L. W. Kneller—Igniting cigars
3361 W. E. Newton—Cotton bale goods

DATED DECEMBER 29th, 1865.

3362 W. Harrison, and T. Walker—Shaping articles of metal
3363 I. Baggs—Construction of stereoscopes
3364 D. Vogl—Show cases
3365 J. J. Harrison and E. Harrison—Looms for weaving
3366 T. Watson—Looms for weaving
3367 J. R. Napier and J. M. Rankine—Rudders
3368 R. A. Brooman—Acetate of lead
3369 A. Barclay—Steam boilers
3370 J. H. Kidd and J. C. Mather—Fluor cloths
3371 J Hall—Boots and shoes
3372 W. Cormack—Deodorising animal and vegetable charcoal
3373 B. Burchall—Side propellers for vessels
3374 E. J Hughes—Colouring matters
3375 W. Edleston and J. Schofield—Keeping fabrics straight in passing through any machine
3376 R. Smith—Balling machines for cotton

DATED DECEMBER 30th, 1865.

3377 T. Parkinson—Throstle machines and flys
3378 A. Knowles, J. Knowles, and J. Barraclough—Extracting wool from cotton
3379 G. Hawksley—Closing charged cartridge cases
3380 R. Beck—Steam engines
3381 J. S. Gisborne—Transmitting motion from one place to another
3382 W. E. Newton—Locks
3383 W. E. Newton—Friction matches
3384 J. H. Johnson—Coverings for floors
3385 W. F. Cochrane—Feeding meal to the bolting reel in flouring mills
3386 D. W. Thomas—Stopping or retarding railway trains

DATED JANUARY 1st, 1866.

1 J. Bullough and W. Rossetter—Looms
2 J. B. Cruxall—Ventilators and mirrors for coverings for the heads
3 N. Thompson—Stoppers for bottles
4 M. Lohren—Substitute for leather
5 T. Prideaux—Furnaces
6 W. Barmingham—Charging furnaces
7 J. Ashdown—Steering ships
8 C Schwartz—Cutting and clea ing finger nails
9 W. H. Norrie—Finishing textile fabrics
10 M. Montague Montagu—Hats and other coverings for the head
11 C. Tayler, W. Dyer, H and J. Dooley—Kamptulicon and similar fabrics

DATED JANUARY 2nd, 1866.

12 P. S. Bruff—Fastenings for the permanent way of railways
13 T. G. Fawcett and H. Wilson—Lifting and lowering weights
14 W. Stauen—Treatment and application of vegetable fibres
15 R A Brooman—Apparatus for the passage of gases and fluids
16 A. and W. Young—Type distributing and composing machines
17 H. Hirsch—Screw propellers

DATED JANUARY 3rd, 1866.

18 H. A. Bonneville—Sowing grain
19 J Pilling and R. Scaife—Spinning cotton and other fibrous materials
20 G Sheppard—Rollers for crushing land
21 W Simons—Conveying materials
22 W. Buckley—Colliery signalling apparatus
23 G Starbuck and C. Sellars—Cement for making good the joints in oil stills
24 G. S. Robertson—Telegraph standards
25 B. Blackburn—Furnaces
26 A. V. Newton—Preparation of pigments

DATED JANUARY 4th, 1866.

27 T T. McNeill—Producing and employing motive power
28 R. Willan—Power looms
29 J. Hiscocks—Combustion of fuel
30 T. E. Vickers—Rolling hoops for wheels
31 W. E. Newton—Distillation
32 N. E. Newton—Augers
33 W. H. Towers—Tanning h des
34 F. Wright—Preparation of fruit beverages of a stimulating character
35 W Clark—Preparing wood pulp for the manufacture of paper

DATED JANUARY 5th, 1865.

36 J. Moore, H. Moore, and G. Lund—Looms for weaving
37 J. Jackson—Grinding grain
38 W. J. Symons and N. A. T. Symons—Smiths' forges
39 J. Ronald—Combing flax and wool
40 Elias Taylor—Building bricks impervious to water
41 J. F. Wheeler—Apparatus for warming the feet
42 E. Walker—Windlasses
43 H. C. P. Cunningham—Working and in the service of gun
44 W. Winter—Engines
45 A. V. Newton—Feeding steam boilers
46 H. Ames—Ordnance

DATED JANUARY 6th, 1866.

47 W. Clark—Bridges
48 F. Tolhausen—Locks
49 W. G. Brattie—Apparatus for lubricating purposes
50 Baron O. de Mesnil—Towing boats
51 H. H. Collins—Copper-plate presses

DATED JANUARY 8th, 1866

52 T. Sager, G Keighley, J. Clegg, and T. Richmond—Looms for weaving
53 T. J. Clanchy—Collars for the neck
54 T. W. Roys—Recovering submerged bodies
55 J. Kerridge and W. Peverett—Assorting grain and seeds
56 A. Gibb—Moulds for casting in metals
57 J. Hodges—Raising and treating peat
58 H. N. Penrice—Forming tunnels

DATED JANUARY 9th, 1866.

59 H. Moore and T Richmond—Looms
60 F. Wise—Flasks and bottles
61 W. S. Guinness—Sewing machines
62 E. Perre—Obtaining motive power
63 T. Bradford—Machines for washing, scouring, and starching
64 R. A. Brooman—Washing and wringing textile fabrics
65 J. H. Johnson—Cleansing wool
66 J. Skinner—Preparing albumenised paper
67 J. M. Macrum—Railway breaks
68 W. D. Grimshaw—Wrench and cutter
69 W. Anderson—Extracting liquid from macerated fibres
70 J. M. Macrum—Distilling oils
71 W. A. Turner and T. T. Coughin—Raising and lowering goods
72 H. Hutchinson—Fabrics suitable for covering furniture
73 A. Leighton—Printing
74 J. Sadler—Nail-cutting machine
75 J Cluban and F. Nightingale—Grinding skins and hides

DATED JANUARY 10th, 1866.

76 R. Shaw—Regulating temperature
77 J., C., and H. Sampson and A. Lockwood—Fo'd ng woven fabrics
78 J. Ireland and S. Davies—Turntable and weighing machine combined
79 C. Turner—Brushing hair
80 E. B Wilson—Furnaces
81 W. E. Newton—Shears or scissors
82 J. Clottou—Securing the rails of railways in their chairs
83 R. A. Brooman—Purifying lamp black
84 R. A. Brooman—Bleaching animal and vegetable fibres and tissues
85 R. A. Brooman—Producing oxygen
86 G. Chetwynd—Treating ores
87 C. O. Pappenguth—Constructing ships
88 J. W Gray—Rice starch
89 W. Baines—Telegraphic signals and posts

DATED JANUARY 11th, 1866.

90 H. Dean—Computing scales for the use of surveyors and engineers
91 P. A. Batchelor and F. Reddall—Retorts
92 T. A. Blakely and J. Vavaseur—Projectiles for breech loading fire-arms
93 J. C. Augns and G Stuart—Drawing off and measuring liquids
94 C. Bartholomew—Getting coal
95 R. Mathers—Toothed wheels for gearing shafts, axles and spindles
96 W. A Rudling—Protecting property from fire and thieves
97 C. Crump—Preparation of tetra-chloride of carbon
98 D. Hall—Furnaces

DATED JANUARY 12th, 1866.

99 W. Eassie—Pile shoes
100 F. J. King—Preserving potatoes
101 F. Sutton—Treatment of sewage
102 W. J. Walsh—Cocks, taps, and valves
103 J T. Smith—Moulds for cast ng the tyres of railway wheels
104 A. H. Hart—Fasteners for binding papers and other like purposes
105 W. B. Woodbury and G. Davies—Finishing impressions obtained from metallic plates produced by the aid of photography
106 P. L. Charon—Cooking potatoes
107 E and H. Sutherland—Obtaining fibre suitable for spinning
108 J. M. Napier—Weighing machines
109 R. T. Sutton—Drying and cleaning grain

DATED JANUARY 13th, 1866.

110 J. C. Thompson—Combustion of gas in gas stoves
111 W. Comery and H. Webster—Looped or knitted fabrics
112 H. A. Dufrene—Pressing bricks
113 W. R. Lake—Lamps
114 W. R. Lake—Substitute for carpets
115 N. W. Wheeler—Condensing steam and other vapours
116 C. N Tyler—Lamp for burn kerosene or hydrocarbon fluids
117 C. S Baker—Harvesting machines
118 W. Gadd and J. Moore—Looms
119 R. A. Brooman—Spring tops
120 H. F. Smith—Mattresses or beds to be employed on shipboard
121 B. Todd—Arsenic
122 C. G. Johnson—Making bricks, tiles, and similar articles
123 H. Guttheimer—Protectors for watches and portemonnaies
124 A. Prince—Preserving timber

DATED JANUARY 15th, 1866.

125 J. Harris—Portable appliances for horses' feet in frosty weather
126 J Hamilton—Propelling ships
127 T. Cornfield—Preventing sl p from wet rails of locomotives
128 J Irwin—Railway signals
129 W. Holdcroft and J. Wood—Self-acting jiggers for potters u-e
130 J. Hooker—Ammoniated soap
131 F. Campbell and W. Burgess—Trenting and curing the tea leaf
132 A. E Johnson—Machinery for sewing
133 G. White—Gas burners
134 R A. Brooman—Looped fabrics
135 H. E. Newton—Water closets
136 A. V. Newton—Electric clocks
137 E. M. Boxer—Cartridges for breech loading fire-arms
138 D. F. Lecocq—Preserving in a fresh condition animal and vegetable substances
139 C. Moriarty—Cleaning the tubes of multitubular boilers
140 C. H. Roeckner—Manufacture of paper pulp

DATED JANUARY 16th, 1866.

141 M. A. Muir and J. McIlwham—Winding apparatus
142 J. and W. Bottom—Scales and handles suitable for knives
143 J. Samwells and S. Nye—Washing straw and other plaits
144 M. Klutz—Toy arms and projectiles
145 S. Dummere—Palliasses and seating for the use of invalids
146 G. Mellor—Nails and spikes
147 W. C. Mann—Felt hats
148 R. Cherry, E. Crossley, and W. Bower—Steam boilers
149 W. Lyne—Apparatus for the prevention of accidents on railways
150 J. Stephens—Plates or curtains applied to enclose stoves fronts
151 M Henry—Printing woven fabrics
152 W. Ager—Breech-loading fire-arms

DATED JANUARY 17th, 1866.

153 M. Ailies—Fasteners for shirt studs and other personal ornaments
154 F. Preston—Machinery used in the manufacture of steel and iron
155 C. J. Croudace and J. Field—Manufacturing and dressing fire bricks
156 J. Kennedy and R. Stanley—Railway breaks
157 T. Allen—Manufacture of iron and other metallic bedsteads
158 J. Banfill—Coal scuttle
159 J. Wyld and J. Kershaw—Making leashes in warps for tape-sizing machines
160 E and F. Feat er and J. Luty—Lubricating the spindles of cap frames
161 E. Cottam—Hydraulic presses
162 M F. Anderson—Refining sugar
163 J. L. Norton and F. L. W. H. Bunger—Discharging water from condensed steam
164 H., E and L Abeheim—Watch or time keeper for watchmen

DATED JANUARY 18th, 1866.

165 C. and S. A. Varley—Electric telegraph apparatus
166 D. Adamson—Vertical steam boilers for marine and other purposes
167 H. Ashworth—Lubricating certain frictional surfaces in steam engines
168 G. Spencer—Vulcanised india-rubber springs for railway engines
169 W. Hibbert—Combination of chemical matters for the cure of contagious diseases
170 J. Williams—Apparatus to facilitate improvement in writing
171 F. Cole—Lithographic presses

DATED JANUARY 19th, 1866.

172 W. Sumner—Casting metal tubes
173 J. A. Nicholson—Protection of the contact surfaces of vessels
174 A. Bennett—Apparatus for giving motion to hand and other fans
175 J Shekleton and J. W. Gibson—Feeding and forcing fluids
176 S. Langdale—Cake for cattle
177 R. Clark—Steam engine boilers and railway rolling stock
178 A. V. Newton—Spinning yarn
179 M. Jackson—Umbrellas
180 W. Parsons—Rock pullies for roller blinds for windows
181 W. Clark—Apparatus for obtaining and applying motive power

DATED JANUARY 20th, 1866.

182 R. E. Kaulbach—Wheels
183 H. Dean and G. A. Wheeler—Pen-holders for supplying the pen with ink
184 G. Tanner and G. Parkes—Producing theatrical or stage illusions
185 W. Bunger—Gas burners
186 G. T. Bousfield—Graining in imitation of wood and marble
187 J. McClenahan—Studs and buttons
188 W. E. Newton—Machinery for pressing and ironing hat bodies
189 W. E. Gedge—Preparing the plant known as coca to permit its incorporation with confectionery of all kinds
190 W. E. Gedge—Careening basin or graving dock
191 A. F. Mineur—Natural manure
192 J. B. Shillcock—Perforated cage for leeches
193 A. Byson—Catching fish
194 W. K. Hall—Steam boilers
195 T. Hutton—Submarine te egraph cables
196 W. Thomas—Machinery for making moulds for ca ting meta s

DATED JANUARY 22nd, 1866.

197 S. F. Linton—Feed water heaters for locomotives
198 C. W. Orford—Force pump
199 J. Broadfoot—Water-closets
200 C. G. Penney—Treatment and utilisation of certain waste products
201 J. Dearden and E P. Holden—Carding engines
202 W. Jeffries—Furnaces used in the manufacture of iron and steel
203 T. Rowatt—Lamps for burning hydro carbon oils without the use of a glass chimney
204 J. H. Johnson—Reaping machines
205 J. R. Butchart—Packing bottles, and in hampers to be used therefore
206 W. C. Jay—Ladies' dresses
207 D. Jones & J. Upton—Bolts for doors and other purposes
208 P. W. Bennitt—Heating furnaces
209 G. B. Woodruff—Sewing machines
210 J. Stringer and G. Birch—Printing yarns
211 B. Walker and J. F. A Pflaum—Travelling cranes
212 H. Harrington—Propelling ships

DATED JANUARY 23rd, 1866.

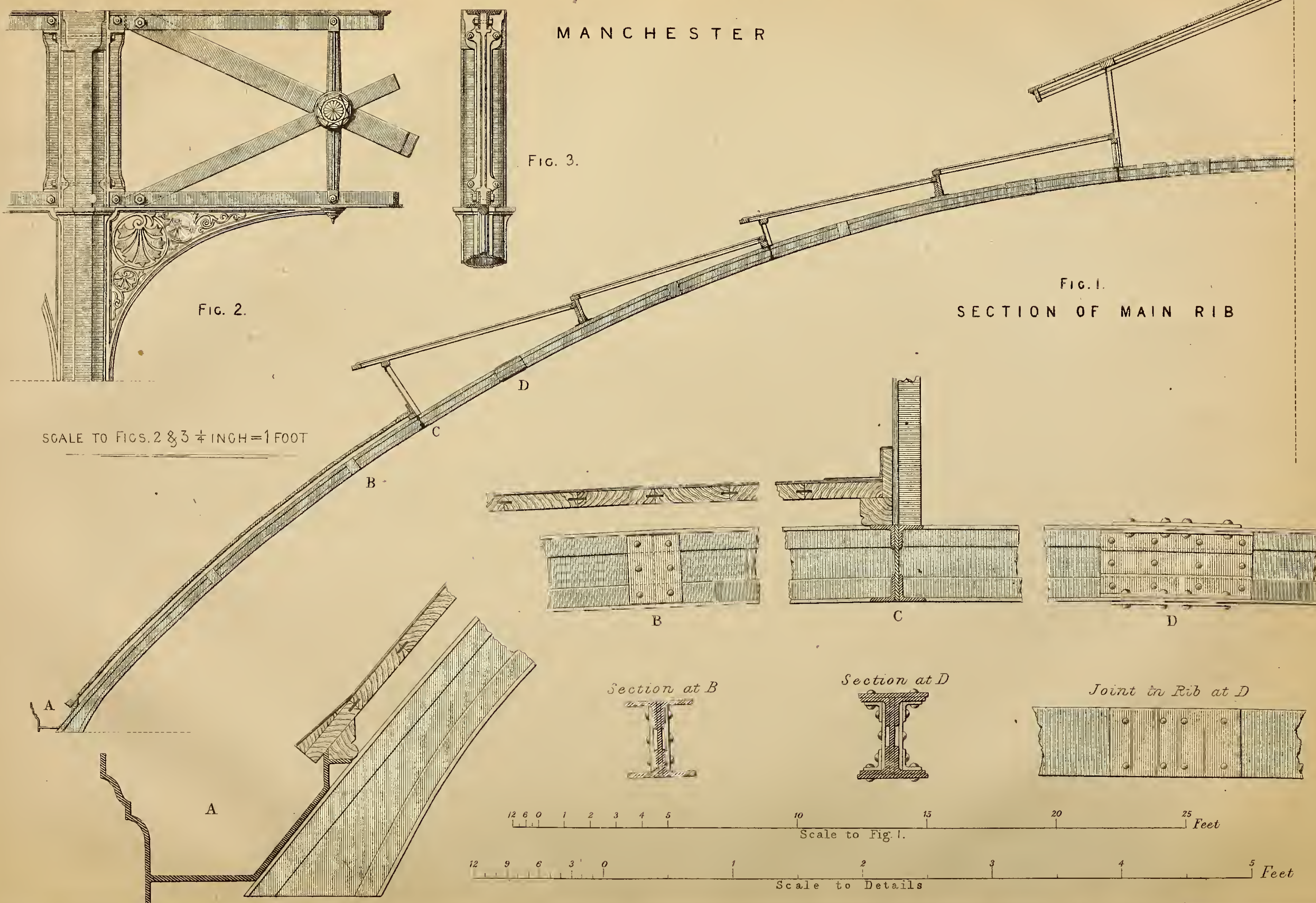
213 N. J. Amies—Cotton balls
214 W. E Gedge—Generator for steam engines
215 T. Baker—Sash fastenings, applicable also to other purposes
216 E. Dare—Pyrotechnics
217 R. H. Bore—Siphon for drawing off liquids
218 T. Prideaux—Heating water for the supply of boilers
219 C. F. H C. Henley—Closing the deck openings of ships
220 W. Brookes—Producing mechanical motion
221 W. Hodgkinson—Fabrics in bobbin net or twist lace machinery
222 F. Wibratte—Submarine electric telegraph tube chain
223 W. Clark—Paper bags
224 R. Moreland—Construction of fire-proof floors for buildings
225 G. J. Bensen—Beet root sugar
226 J. Howard and E. T. Bousfield—Construction of steam boilers
227 E. Hopkins—Correcting the deviation of compasses in iron ships
228 M. Silvester—Removing and preventing incrustation in steam boilers

DATED JANUARY 24th, 1866.

229 J. W. Evans—Metallic cases for the reception of spiral springs for railway carriages, waggons and other vehicles
230 W. Dore, J. Tapley, & J. Cordwell—Preparing cotton
231 M. H. Lishman and E. Chambers—Apparatus for drying moulds
232 W. K. Hall—Boats
233 E. and J. Turney—Treating hides and skins in the manufacture of leather
234 D. Lord, T. Lancaster, and R. Bennett—Looms for weaving
235 J M. Watt—Composition for coating materials and structures

ROOF OF THE LONDON RD. RAILWAY STATION.

MANCHESTER



THE ARTIZAN.

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MARCH 1st, 1866.

ROOF OF THE LONDON ROAD STATION, MANCHESTER.

In the accompauying plate (No. 298) we have illustrated, from sketches supplied to us by Mr. J. J. Birckel, portions of the above roof, which broke down towards tbe end of January last just as it was on the point of completion. Mr. Birckel, who went to the scene of the diaster soon after its occurrence, reports to ns as follows :—

The roof, which is made in the shape of flat arches, consists of two spans about 95ft. in width, supported by lattice girders resting upon stout cast iron columns, at distances of from 76ft. to 88ft. 4in. The principals are placed at distances of from 5ft. to 5ft. 3in., but are not all of equal strength, there being two or three principals of secondary size between the successive main ribs of the roof. The hackbone of these principals is illustrated upon our plate, and consists of a plate girder 12in. deep, the web being made of plates $\frac{3}{8}$in. thick, stiffened at the upper and lower edges by angle irons of $2\frac{1}{2}$in. × 3in. × $\frac{3}{8}$in. section, and the joints of the web and of the angle iron flanges, are made on the assumption that all the parts of the rib will have to resist a compressive strain. The trussing of these principals is similar in every respect fo the celebrated Birmingham New-street Station roof, and is defective, thereforc, in design, because those bars, which in reality act as struts, are treated as being mere tie bars, and those which act as ties are treated as being struts, with this aggravating feature in tbe present instance, that the vertical assumed struts, but really tie bars, are made of cast iron whicb renders them totally unfitted for thc duty they havc to perform.

This subject was so tborougbly investigated in our papers "On the Construction of Iron Roofs," published in The Artizan of August, Scptember, and Octoher, 1862, that we again must refer our readers to tbose papers. The purlins consist of plate girders similar to those described above, and ought therefore to bc quite equal to the duty which tbey have to perform. About two-thirds of the span of the roof are covered with heavy ribhed glass $\frac{1}{4}$in. thick, resting in wooden sash framings, so constructed as to allow for ventilation, and the remaining portion is covered with slate, resting upon a continuous layer of $1\frac{1}{4}$in. planking. The central portion of the covering is raised considerably above the principals, and rests upon ⊤ iron standards, not provided appareutly with louvre boards, thus making a liberal allowance for ventilatiou.

Notwithstanding tbe defective construction, or ratber dcsign of tbe principals pointed out above, the immediate cause of the disaster did not arise from this, but was due to the defective construction and weakness of the lattice girders which carried the roof, and to their inadequate fasteuings and hold upon the columns whicb form tbe primary supports of the roof.

The lattice girders, illustrated in figs. 2 and 3, are 6ft. deep and consist of tension and compression flanges connected by diagonal braces and vertical stays at the poiuts where tbe braces abut upon the top and bottom members; from distance to distance, also, tbere are vertical stays at the point where the diagonal braces cross eacb other, these, however, occur only in every alternate bay of braces. The bottom or tension flange consists merely of two angle irons of 6in. × $4\frac{1}{2}$in. × $\frac{5}{8}$ section, and the top or compression flange consists of two similar angle irons, stiffened by the addition of two layers of plates 12in. broad by about $\frac{1}{2}$in thick; the diagonal braces consist simply of two flat bars, 9in. broad by about $\frac{3}{4}$in. or $\frac{7}{8}$in. thick, and the bays have an opening of about 12ft., so that tbe length of these bars is not far short of 14ft. In designing the girder it was evidently assumed that these braces would act as ties, and that the strain would be resisted by those only which rise from the centre towards the columns, hence the diagonals which fall from tbe centre towards the columns are made of a single bar only 6in. hroad; the vertical stays are made of cast iron bolted through the angle iron members, to which the diagonals also are bolted and further secured by one or two rivets; at the ends of the girders the top and bottom flanges are connected by means of a vertical cast iron stay, secured to each flange by means of one $1\frac{1}{2}$in. bolt.

With the illustrations in the accompauying plate to assist them and the description which we have thus given we think our readers will be ahle to judge for themselves wbether we are far wroug wheu we express a doubt as to such a structure being a girder at all. The theory of the stability of girders assumes as a primary condition of the problem of stability that the top and bottom flanges which are to supply the required resistance, should be rigidly bound togetber, and experience bas proved long since tbat unless lattice girders of long spans are supplied with solid webs for some portion of their length at the ends, they take a permanent set at tbe points wbere they meet the abutments or supports. Now, in the so-called girder under consideration, the top aud bottom members are connected only at distances of about 12ft. by thin bars which are neither ahle to resist any compression strain, nor yet to offer auy lateral resistance, and takiug into consideration the limited number of holts and rivets which form the connections, we may safely infer that they offer but little rigidity; besides this, the precaution of supplying the ends of the girder with solid webs has also been disregarded; and thus we may affirm that the structure before us is wanting in all the first elements that constitute a girder. The portions of the roof yet standing bear evidence of the truth of our remarks on this point, for some of these diagonal braces have twisted and buckled like so many strips of cardboard, thus showing tbat no rigid connection did bind the upper and lower members of the girder together. This point also was dwelt upon at great length by Mr. Brunlees, as scientific referee, in his evidence at the coroner's inquest, and this portion of it is tbe only retrieving feature in the cobweh of rubbish that was delivered on tbat occasion.

Ill-designed and unsubstantial though this all-important element in the whole structure be, yet would this catastrophe in all probability never have happened had the means provided for carrying the girders upon the columns offered an ordinary amount of security only. By reference to the illustration, the reader will perceive that the girders rest upon a lip cast on to the columns, and having a projectiou of 3in. at the utmost, for it should be observed that the spandril sbown in our sketch is merely bolted on as an ornament, and forms no support, and tbat they are further secured to tbe columns by means of four $1\frac{1}{4}$in. bolts through the cast iron vertical stay which unites tbe top and bottom flanges: now in tbe case of a girder upwards of 80ft. long, a supporting lip of 3in. in length should at once be dismissed, as being of no further use than that of facilitating the erection of the structure, and thus it may be said that these girders, with tbe wbole of their load, were hung upon eight $1\frac{1}{4}$in. bolts, whicb were not even provided with lock nuts!

Mr. Brunlees, in his evidence, entered very minutely into the calculations of weight, extraneous pressures, and loads to which tbe roof might be subject, and showed that these bolts were quite equal to resist the *shearing strain* whicb, under given circumstances, they would have to sustain, and we see no ground for finding fault with that calculation

but Mr. Brunlees forgot to take into consideration the direct *horizontal pull* to which these bolts, and the ears or lugs of the cast-iron stay through which they take hold of the girders, might be subjected by any deflection of the girder below the horizontal line. That this pull may reach to an enormous amount is well known to those even who have but an imperfect knowledge of the theory of funicular polygons and of the composition of forces; and as it appeared in evidence that one of those girders did deflect ⅝ of an inch below its original position, it is probably to the strain thus thrown upon the lugs of the cast-iron stay that the catastrophe is due. Had the supporting lip projected 12in. instead of 3in., only the result might have been quite different; under any circumstances, however, this mode of fastening was reckless in the extreme, for it required but a few turns of the nuts of the bolts in question to bring the whole structure to the ground, and the vibrations caused by the continuous movement of heavy engines and trains, increased by the fact of the station being raised above the ground level, was sufficient to bring about this result, seeing that the bolts were not provided with lock nuts.

In conclusion we feel bound to say that the structure, considered as a whole, is a disgrace to the engineering profession of the country, nor could the railway companies, or their engineers, have escaped scot free had the poor fellows, the sufferers by this calamity, been assisted by counsel instructed by a competent engineering authority.

It was a fortunate circumstance for the contractors also, that the whole remaining portions of the roof, or at any rate of the girders, show evident signs of weakness, else the damage would in all probability have been saddled on their backs.

RECENT IMPROVEMENTS IN MARINE ENGINEERING.

(*Continued from p.* 31.)

In continuation of the opening address to the Association of Assistant Engineers, in Glasgow, the author, after giving a short summary of his previous paper in its leading points, proceeded to describe the engines of the three trial frigates—*Constance*, *Octavia*, and *Arethusa*.

The engines of the *Constance*, by Randolph, Elder, and Co., are of the diagonal direct acting type, having three 22½in. cranks on their shaft, the centre crank being exactly opposite to the outside ones, and to which centre crank the two 60in. high-pressure cylinders, one on each side, are attached by their respective rods; while to the two outside cranks are attached four 78in. low-pressure cylinders, one of these 78in. cylinders being on each side of the high-pressure cylinder. Steam is first admitted to the high-pressure cylinders by gridiron plate valves working on the top side of the cylinders, and being expanded, a various amount in that cylinder is, after completing the stroke, exhausted through top and bottom ports on each side of the cylinder on to the back of short D slide valves that admits steam into the low-pressure cylinders, and which at that moment are open by their amount of lead, for the arrangement of the cranks is such that the piston of the high-pressure cylinder arrives at the bottom of its stroke at the same moment that the pistons of the low-pressure cylinders on each side of it arrive at the top, and *vice versâ*; thus the steam, after doing its work in the high-pressure cylinder, does not require to wait until the low-pressure cylinder needs it, but is immediately exhausted from the one to the other, with the great advantage of occupying a minimum amount of inefficient space in the shape of receivers and steam passages. It may here be observed in passing that this principle of immediate exhaust into the low-pressure cylinder, as above described, forms the first desideratum in double cylinder engines, and has been obtained in inverted cylinder screw-engines as well as in the diagonal form of those of the *Constance*. In inverted engines of this class the low-pressure cylinders only, are above, and attached directly to the cranks, the high-pressure cylinders being bolted to the athwartship side of them, and passing their power through beams which are attached by links to the cross-head of the connecting rods, these beams or side levers, thus giving the desired opposite direction of motion of the high and low pressure cylinder piston. Good examples of this class of engine have been adopted by the African Mail Company. It is noticeable that by inverting this arrangement of screw engine it would be in a condition that would not be difficult of adaptation as a paddle engine, the screw-propeller shaft in the one case becoming the paddle shaft in the other. It has not, however, as yet, been found convenient or desirable to adopt that arrangement of double-cylinder engine for the paddle-wheel. But a diagonal direct acting type (well represented in the Pacific Royal Mail steamers) offers a more advantageous arrangement for the paddle-wheel engine. Such engines are of an arrangement similar to the screw-engines of the *Constance* with the difference, however, of the angle towards the crank shaft being inclined upwards instead of downwards, the angle the cylinders make with each other, thus obviating the necessity of right-angled cranks, and thereby obtaining for the double-cylinder engine the much to be desired opposite cranks. Let it not be thought, however, that opposite cranks are an indispensable arrangement of that kind of engine, for we have them constructed like common marine engines, with one cylinder to each engine, and cranks at right angles, the engine with the small cylinder being, in virtue of the high pressure of steam, equal in power to the engine with the large cylinder working with expanded and, consequently, less powerful steam. This arrangement of engine, although devoid of many of the advantages of the other descriptions of double cylinder engines, has, however, given considerable satisfaction in practice, and develops an economy which the common marine engine has not arrived at. Where it is adopted it has been found best to exhaust the steam from the small cylinder into a superheater at one end, from which it is drawn at the other end to supply the large cylinder, which supply is not wanted until half a stroke has taken place, since it was exhausted from the small cylinder. In the *Constance's* engines the steam is ultimately expanded in the large cylinder to a pressure of 10lbs. below atmospheric pressure, an amount of expansion that cannot practically be obtained in any other class of engine. All her cylinders are steam-jacketed, and the steam condensed in Davison's surface condensers.

The *Octavia's* engines, by Maudslay and Field, seem to be a sort of compromise between the double cylinder engine and the common marine engine. They consist of three horizontal cylinders, each 66in. diameter, with a stroke of 3ft. 6in. These cylinders are, by their respective connecting rods, attached directly to the cranks, of which there are also three, which equally divide the circumference of the circle which their centres describe. In this engine it will be seen that six renewed efforts are given to the shaft in the course of one revolution, which certainly ought to give a more equable motion and greater uniformity of action than when only four efforts are given, as in common marine engines. Maudslay undoubtedly adopted this arrangement of engine in order to reconcile a high rate of expansion and a high speed with a regular motion. Expansion in these engines is obtained simply by the slide alone, which is worked from a motion shaft driven from the crank shaft by a train of four spurwheels. The two intermediate wheels of this train are fixed in a shifting frame, which frame, by being elevated or depressed its full amount, alters the position of the eccentrics in relation to the cranks, and thus reverses the engines; a narrow limit of variable expansion is also commanded by means of a slight alteration of this intermediate wheel frame. The cylinders of the *Octavia's* engines are also steam jacketed all round as well as top and bottom, which jackets are filled with superheated steam. The superheaters consists of a number of horizontal tubes in the up-take, flattened for the purpose of giving free access to the smoke and also to expose a more efficient heating surface. These engines are also fitted with surface condensers, on something like Hall's plan, consisting of about 5½ miles of short half-inch copper tubing, which exposes a condensing surface about equal to the evaporating surface in the boilers. The steam is condensed in the tubes whilst the circulating water is pumped through between them. A fresh water still is provided, to make up the necessary amount of waste feed water from the boile

an accompaniment that our present experience in surface condensers renders unnecessary and even objectionable.

As to the *Arethusa's* engines, by Penn, they are of the horizontal trunk description, a type of engine that his name has been so long familiarly associated with, more especially in the engines of our Royal Navy. His arrangement of trunk engine may be shortly described as follows:—The cylinders stand on one side of the crank shaft, while the condensers, air pumps, and their necessary adjuncts, are placed on the other side of the shaft. Through both ends of the cylinder there passes a large open trunk working through stuffing boxes in the cylinder ends. To this trunk the piston is fixed, being, in fact, cast in one with it, whilst to the interior of the trunk, and in the middle of it, the pin is fixed to which the vibrating end of the connecting rod is attached, the other end of the rod engaging the crank pin in the ordinary manner. The air pump is double acting, and is set within the condenser, being worked by a rod attached directly to the piston. The adoption by Penn of this stereotype style of engine for the *Arethusa*, under the peculiar circumstances that she was placed as a trial frigate, shows that he was not so much impressed with the importance of expansion as the other competing engineers were, or, at least, he did not consider that the amount necessary to carry expansion entailed any special arrangement in his engines further than an increased available diameter of cylinder over and above what was simply due to the nominal horse power per the Admiralty rule. In fact both Penn's and Maudslay's engines had cylinders of a capacity one half to three quarters more than would, under other circumstances, have been considered necessary. The *Arethusa's* engines had cylinders equal to 80in. diameter. We say equal because the actual diameter was reduced in available area, an amount due to the area of the trunk. The stroke of the pistons being 3ft. 6in. These engines are also fitted with surface condensers on Spencer's principle. Now, although we may admire Penn's beautiful arrangement of horizontal trunk engines, yet it is impossible to reconcile the use of the trunk with a high economy, seeing that its reciprocal motion exposes its external as well as its internal surface to the cooling influence of the atmosphere at each stroke, thus acting on its return stroke as a too efficient surface condenser in the interior of the cylinder. Steam jacketed trunks might, however, be used with great advantage, they would also offer a good medium for passing the steam into the interior of the piston, although some device such as a hollow rod at the bottom of the piston working through a stuffing box at the end of the cylinder, would be necessary to take off the condensed steam. In some engines steam is admitted into the interior of the piston at its top side, by means of such a hollow rod, and the condensed steam is drawn off by a similar hollow rod working through a stuffing box at the lower side of the cylinder, but on the whole it would appear that the admission of heated steam into the interior of the piston, is a refinement which, however desirable, when obtained by any such means as these is obtained at too great a price, namely, that of additional stuffing boxes, and thus an increased risk of leakage into the cylinders, and which moreover with trunk engines is already a maximum risk, owing to the difficulties that attend, and the care that large trunk stuffing boxes require. For it must be remembered that although an outward leakage of steam through the cylinder stuffing boxes is of little consequence and easily discovered, an inward leakage to the vacuum side of the piston is a very different matter, and in large engines with a very small leakage would decrease the gross value of pressure on the piston by several tons; besides this, the air so subtiley vitiates the vacuum that the leak is almost imperceptible and often undiscovered. Much annoyance in this respect is often occasioned by leakage at the cylinder escape valves, which instead of being the most carefully fitted details, are too often the reverse.

In regard to the engines of the *Arethusa*, as well as to all other common marine engines with cranks at right angles, they appear to us ill adapted for carrying out the amount of expansion that is almost certain to be before long more extensively adopted, and, together with high pressure steam, much further developed than it has yet been. So long as comparatively low steam pressures are used, and expansion not carried more than two-thirds of the stroke, the common two cylinder marine engine will work with fair uniformity, when well balanced otherwise, but when higher steam pressure with a shorter admission is used in such engines, it will be found that a violent jerk at the commencement of the stroke, with a languid action towards the end, will be the certain and injurious accompaniments. To obviate this difficulty, there have been, besides the double cylinder and the three cylinder engines already described, a few more arrangements introduced, although not extensively so as yet, amongst which Scott Russell's three cylinder engine is most worthy of notice. It is arranged thus: instead of dividing the driving circle with three cranks like Maudslay, he divides it with his three cylinders, attaching them all by their respective rods to the same crank pin. He places one cylinder on each side of the crank shaft, inclined upwards, and inverts his third cylinder directly over the crank. A modification of this arrangement he has also adapted to paddle engines. One eccentric is made to work the valves of all the cylinders, for there being only one crank, it necessarily follows, that the setting of the eccentric for one cylinder answers for both the other cylinders, in whatever position they may be placed in relation to each other, the only difference necessitated being that, while one set of valves may be wrought from the eccentric by a single jointed rod, the eccentric rods for the others must all be double jointed. For the purpose of balancing this engine, a single air pump is worked by a crank keyed in the best position for so doing on the crank shaft. Many other arrangements of marine engines might be described, but as none of them offer features of such importance as would warrant further attention at present, we will proceed to consider the subject which, after expansion, is most deserving of our careful attention, namely, that of steam jackets around cylinders. And although we cannot enumerate them in the category of recent improvements, seeing that James Watt, fully alive to their importance, almost invariably adopted them for his engines. It has, however, taken nearly all the years that have elapsed from his time to this to convince our engineers that Watt, in using them, was not perpetrating a gross folly, but, on the contrary, was taking to his aid an efficient and simple economiser of power. It has been, until lately, generally but erroneously considered that the waste of heat by radiation was the only loss that escaped from the cylinder, and consequently, that loss would be rendered none the less with the adoption of steam jackets, which would, indeed, be strictly true were radiation of heat the only loss that arises in or from the cylinder. But unfortunately the principal loss is occasioned by another and entirely different action that takes place in the interior of the cylinder. This action consists of an alternate condensing and evaporating operation that is set in action in the interior, and is brought about thus: when steam is first admitted into the cylinder we may suppose it to be at its initial temperature as well as pressure; a part of its heat is, however, immediately imparted to the metal of the cylinder, which has the effect of condensing a part of steam into water, being a quantity altogether independent of the condensation which results from the development of power from the steam, for as the steam does work in the cylinder it of course loses heat in proportion to the amount of power taken out of it, and the amount of heat left in that way, may be taken as the equivalent of the power gained. And as the steam is thus expanded downwards in the cylinder it falls in pressure as well as temperature, consequently an additional condensation into water is the result. At this point, however, namely, about the end of the stroke the following action takes place: The cylinder having been originally heated by the entrance of the higher pressure, initial steam has now a latent heat in excess of the ultimately expanded steam, consequently it gives out this excess heat, raising the temperature of that steam, which it does by directly boiling off into vapour the water or condensed steam contained therein at the expense of a frigorific action on itself, which, although raising the pressure in the cylinder, is rendered unavailable as taking place at the end of the stroke, and moreover when the exhaust is open for the return stroke, and consequently the cylinder on the side of the piston we are dealing with, in direct and open communication with the condenser, further vapour

by the cooling influence of the condenser is deposited in a shower of dew on the sides of the cylinder, and further heat is drawn from the cylinder in evaporating these watery particles, so that at the end of the revolution or double stroke, the metal of the cylinder is again in a condition ready to absorb as it were the heat from the freshly admitted steam, and after doing so is again prepared to impart that heat wastefully in useless evaporation.

With steam jackets, however, although a loss of heat from radiation does go on, this loss being rendered a minimum by the use of a felt and wood lagging, we find that a vastly more wasteful condensing and evaporating action that would otherwise go on as described, is not only absolutely arrested and prevented, but the steam is made to do duty as if it were a dry gas, that is to say, the condensation that would naturally take place as the steam did work, and lost heat, is also prevented; that is, if steam of the same temperature as the initial working steam is held in the jackets; and to carry this still further if the jacket steam is superheated to a higher temperature than the initial working steam, it will be found (other circumstances not militating against it), that a higher duty would be given out by the steam used, than it could even theoretically give when unaffected in temperature by any other cause than that which follows its own expansion, in short, a higher duty would be developed under these circumstances, than would otherwise be obtained although working under the same conditions as a dry gas. In fact, in the one case it would be found that the loss is only 19·6 per cent., while in the the other it reaches the enormous proportion of 44·5 per cent., proving conclusively the necessity for steam jackets where expansion is carried out to any great extent, and showing their importance generally as steam economisers. In spite of all this, however, many engineers are far from being alive to their vast importance. Sooner or later, however, their adoption will be forced on unbelievers by the specifications of shipowners, many of whom already fully appreciate the benefits that arise from their application. The increased expense, size, and weight of the jacketed cylinder over the plain cylinder may deter many engineers from adopting them, but a full appreciation of their after value would far outweigh in importance the comparative item of first cost. It is neither necessary nor advantageous to make the jackets wider than they can be safely cast, and which, in the largest size of cylinders, need not exceed 2in. to 2½in. We will now pass on to the surface condenser, although surface or dry condensers, as they are sometimes called, like steam jacketting, cannot be called a recent application, seeing that Watt also used them in his earlier engines, and that in preference to the common or jet condenser. This he did erroneously, however, and was induced to employ it in preference to the common condenser for different reasons than those that prompt us to adopt it now. He preferred it for the purpose of saving the power which he would otherwise have expended in pumping out the injection water After Watt's experience and rejection of the surface condenser, it was almost entirely forgotten, only to be revived some thirty years ago by Mr. Samuel Hall, and this time it was not brought forth as fitted for stationary but marine purposes, and for a different object than that which prompted Watt to adopt it: the object in this case being not the saving of power in pumping out injection water, but for the purpose of supplying the boilers with fresh instead of salt water, which had been found so detrimental in bringing about a premature decay of the plates. It must be borne in mind, however, that although the above reason resembles closely in some respects the reason that we now adopt surface condensers for marine engines, yet it is not so; for although employing the same means, namely, that of supplying fresh water to the boiler, we do so to bring about a different result than that of preserving the boiler's rapid decay, which, moreover, our present experience in surface condensers does not assure us is attained by their adoption, but the contrary, namely, a more rapid decay of the boiler, has been rather advanced as the result of their use; but what now induces us to adopt the surface condensers for our modern marine engines is primarily the great advantages that accrue to the use of high pressure steam worked expansively; and as the limit to using high pressure steam is not caused by our inability to make boilers sufficiently strong to withstand it, but is caused by the enormous waste by blowing out, that, with the use of sea water, is rendered necessary to prevent the strongest boiler from being burned and completely destroyed, on account of the thick layer of scale that would otherwise concrete on the plates and almost entirely prevent the transmission of heat; and practically a higher pressure than 40lbs. cannot in marine boilers be used with safety or economy unless a surface condenser or other means for supplying the boiler with fresh water be also adopted, for at that pressure—namely, 40lbs., which corresponds to a temperature of nearly 290°—a deposit of sulphate of lime will take place without any concentration of the water whatsoever, so that it necessarily follows that the more blowing off there is, and consequently the more feed water admitted to compensate for that blowing out, there will just be the more deposit to blow out, so that we may consider that 40lbs. is the limit of boiler pressure at which condensing marine engines may safely work, although 42lbs. may be stated more correctly as the pressure at which this deposit of non-concentrated water takes place.

The more prominent surface condensers, as being the most extensively used, we will now shortly describe. The differences of the surface condensers now used, however, do not lie so much in principle of action as in the details of construction, the best arrangement of which details, and more especially those connected with the tube packing, proving in the surface condenser, however, a matter of the most vital importance. As to the fortune that followed Hall's original condenser, we need not dwell at any length. It was tried shortly after its introduction by Mr. David Napier, and occasionally afterwards by other enterprising engineers both in England and America. It did not, however, for reasons which the above sufficiently explain, achieve the success that was anticipated for it, although, as a surface condenser, it was nearly as effective, and, in fact, almost the counterpart of some of our present arrangements, of which we have a great variety, differing, however, as has been already stated, more in the mode of fixing and making air-tight the tubes in the tube plates, and it is on these differences that most of the patents are based. In some condensers the water is circulated amongst the tubes, while the steam is condensed within them, whilst in others the water is forced or drawn through the tubes, and the steam condensed by exterior contact with them, and of these two modes the latter is now preferred. The surface condensers that are now best known and most extensively used are Davison's, Horn's, and Spencer's, which condensers the author fully described with the aid of drawings, and then concluded the subject of surface condensers by enumerating the disadvantages which at present accompany their adoption, but in doing so he had no desire to detract from their great importance and value that legitimately is theirs, namely, that of allowing the engineer safely to work his boiler at any pressure, and thus giving him an unlimited command of the resultant advantages.

It has already been stated that a premature decay of marine boilers has been said to result from the adoption of surface condensers. But these reports cannot, in many cases, be considered reliable, and in others that decay has not always been satisfactorily traced to result from the condensers; for, quoting Spencer, "Although some boilers have been reported to have died very young, of a disease resulting from the use of surface condensers, yet, as the informants have not supplied date of birth or death, symptoms of illness or appearance of the body after death, nor given us the results of any *post mortem* examination, we will do well not to register cases of such an anonymous description;" although we should be ever ready to obtain information of a reliable character that is likely to bear on this important subject. That a corrosive action of a very remarkable and capricious nature has been in some instances set in operation on the boiler plates, is undoubted; the plates on which this action has taken place presenting a pock-pitted appearance, and is said to be occasioned by the action of the verdigris distilled in the condenser from the brass tubes. Others say, however, that it results from the use of pure distilled water, and to back their opinions they advance the fact

that where fresh-water stills have been used for supplying the waste feed water, this corrosive action has been found to be of a more virulent nature than where the still is altogether discarded, and the waste simply made up by sea water, the pock-pitting action, especially below water level, being then almost entirely arrested. That opinion, however, cannot be received without objection, and the objection is, that the corrosive action is prevented not directly by a non-corrosive virtue being infused into the feed water by the admission of sea water, but indirectly by the presence of that sea water causing the deposit of a thin film of scale on the interior surface of the boiler, which is sufficient to act as anti-corrosive armour, without being sufficient to affect the transmission of heat appreciably. And this is borne out by the fact of their being a slight tendency to corrosion about and a little above the ordinary water level, where the water, by being only in occasional contact with the boiler plates, does not deposit scale. And as yet we cannot state with certainty whether these boilers are to be longer or shorter lived than those fed from the hot well of the ordinary jet condenser. That they save expense in respect of scaling is a fact, and that with equal strengths of boilers working at equal pressures, especially when these pressures are high, the former have superiority in respect of safety over the latter is now settled beyond question. There are, however, other evils of no light nature that attend the application of the surface condenser. Amongst these may be enumerated the increased first cost—a very considerable amount, when we consider that nearly a square foot of brass or copper condensing surface has to be exposed for every square foot of heating surface in the boiler. Then there is a greatly increased number of air-tight joints to be made and kept good. The difficulties of cleaning and removing leaky tubes, besides the accumulation of tallow, which often occasions a choaking up of the air pump foot valves and also impairs the efficiency of the bucket and discharge valves owing to the tallow coming through the pumps in the form of small balls, which prevent the perfect closing of the valves. Then there is an additional pump required for circulating the condensing water, although as a set off against this we have the power of decreasing the size of the air pump, a compensation, however, which many engineers do not consider it expedient to take advantage of, seeing that if a great leakage of the tube plates was taking place, the large air pump would be necessary to throw out the increased quantity of water. And those engineers who still stick by the ordinary size of the air pump, generally attach the injection sluice, rose, and other connections, for the purpose of converting the surface into an ordinary jet condenser at pleasure.

Some engineers, while attaching the jet condenser appliances, still reduce the size of the air pump by one half, while they work alongside of it a similar pump to act as the circulator when working the surface condenser. In the event of its being desirable to use the jet alone, however, by an arrangement of stop valves both pumps may be converted into air pumps, with a capacity sufficient to withdraw the increased quantity of water. Condensers of this description have been found to work satisfactorily in practice. The complication of stop valves, &c., entailed in this arrangement, however, renders it other than commendable. Some engineers, on the other hand, have endeavoured to do away with a separate pump for circulating purposes altogether, this they do by making a double acting pump work on one side of the piston plunger as an air pump, while the other side is made to act as the cold water circulator; but this, although apparently a commendably simple plan, does not in practice give the satisfaction that might be anticipated for it, leakage, and consequent mixture of the fresh and salt water, with other evils, being its disadvantages. Some engineers, again, use only one air pump, and work the corresponding pump on the other engine (which, with a jet condenser, would also be an air pump) as a circulating pump. This is a practice, however, which, for sea-going vessels, is not to be recommended, seeing that in the event of a break down of the single air pump the engine may be completely disabled, whereas, when two are fitted, in the event of accident to one the other may be made to do duty for both, with perhaps the loss of a little power, which, under the circumstances, would be comparatively of little account. Some endeavours are now, however, being made to supersede the surface condenser with all its attendant evils.

These efforts are expended principally in endeavouring to discover some chemical or mechanical agent that, introduced into the interior of the boiler will prevent the scale from forming. As to the first of these agents, namely, that of chemical appliances, it has been too often found that the cure is worse than the disease, in short, the medicine often accelerates the decay. This has rendered engineers and ship owners chary of experimenting in that direction; as to mechanical appliances, although they may to a great extent prevent the scale from concreting on the plates, still the deposit is none the less there, and is little if any improved as a heat conductor, lying as it does at the bottom of the boiler in a sludgey sort of state, the principal advantage arising from which is, that the deposit is more easily removed at the end of the voyage, than it would otherwise be. Another plan than that of the expensive and cumbrous surface condenser for supplying the boiler with water that will not salt up, has been recently patented by a Frenchman, and which augurs well for success, it consists of a vessel on the bottom of which is laid faggots of osiers. The feed water which may be taken from the hot well of the condenser, or in high pressure marine engines from the sea, enters at one end of this box or vessel, where it is treated with highly superheated steam rushing in on it from the other end. The water is thus suddenly raised to that temperature at which it deposits its solid compounds, which deposit is collected on the willows at the bottom of the box, and which may be removed at certain intervals for the purpose of scaling. Should this operation prove economical and succeed generally as well as anticipated, we shall obtain by it almost all the advantages of the surface condenser, without many of its present attendant disadvantages, and if succeeding, there may spring therefrom such a revolution in the whole system of marine enginerring, as we have scarcely dared to anticipate, however much we may have desired it. In conclusion, we will only add that few will deny that however great "Recent Improvements" may have been, there is still a vast field left for the efforts of genius and improvement, and many prizes still left well worth striving for. True, the awards may neither be an immortal name nor worldly gain, but a right minded man always has his reward, if it be nothing further than the pleasure of having benefited his fellow men.

ON STEAM AS THE MOTIVE POWER IN EARTHQUAKES, VOLCANOES, &c.

By R. A. Peacock, Jersey.

(Extracts from an unpublished MS.)

It is an interesting question whether volcanic operations originate from the internal heat of the globe, or from certain chemical operations going on beneath and around us. Perhaps the truth is that both contribute more or less. Be that as it may, heat, whether derived from one source or the other, will certainly produce steam when brought into contact with water. And it is impossible to overlook or ignore the tremendous power of highly heated, saturated steam, let the origin of its heat be what it will. Is it possible to imagine that such steam does nothing?

Pumice, scoriæ and smoke, having come up, as we shall see, from volcanoes in very deep water, prove the presence of melted lava, and one of two things must necessarily have happened. Either the water with its immense pressure and quantity extinguished the lava (producing steam at the same time), and in that case there could have been no action afterwards; or otherwise the lava was sufficient in bulk to convert the water into steam again and again at several miles in depth of water, and even to remain as melted lava afterwards; which latter we must suppose to have been the case. Because we shall see in No. 40, that a submarine volcano (producing pumice) is known to have been active for 2,000 years, and we shall see also in Nos. 41, 42, 43, that volcanoes (producing scoriæ and smoke) occur *periodically*, in water of as much as 2,800 and 3,000

fathoms deep. The internal fire is therefore a vast mass, or masses, which the ocean with its variously estimated average depth of from two to five miles cannot quench. The ocean is but as a very thin film, its depth being only about a one thousandth part of the earth's radius. It is probable there are vast areas of fire, consisting (say) of melted lava, and of *hundreds of miles in depth*; else they would necessarily have been extinguished long ago by the statical depth of three or four miles of water. As a matter of fact, the ocean does *not* extinguish the fires, and steam must necessarily be produced: which in its turn will necessarily produce those shocks which we call earthquakes. Professor Bischoff calculated that one eruption of a volcano in Iceland ejected as much lava as the bulk of Mont Blanc.* And yet, more was left behind, for the geysers continue to act with undiminished vigour. I believe, with Mr. Hopkins, that the present condition of the shell of the earth is, that it is a solid mass of 800 or 1,000 miles thick, containing numerous cavities filled with fluid incandescent matter (and some of them, I say, also with steam, and perhaps others with steam and gases), and either entirely insulated, or perhaps communicating in some cases by obstructed channels.† Such cavities must be distant from the surface of the earth, in countries free from volcanoes, earthquakes, geysers, &c.; but so near the surface in the disturbed localities, that water gets access to the lava and steam is produced. The heat of the molten lava in these cavities was perhaps what led Humboldt to believe that in consequence of the progressive increase of 1° F. in every 40, 50, or 60ft. (as the case may be), as we descend into deep mines, that the nucleus itself was only about twenty-five miles below the surface. These respective increases of 1° in 40, 50, or 60ft. as you descend mines in *different* countries would seem to signify that the fluid lava exists at *various depths* in different localities and countries, as the hypothesis requires. The dividing walls of the cavities perhaps consist of granites, and elvans containing black non-lithia micas, which Sir H. de la Beche and Mr. Dillwyn found could not be melted by the greatest heat of a smith's forge,‡ which is probably from 3,000° to 3,300° F. If any reliance can be placed on the following hypothesis, we may not believe that the interior nucleus (of about 6,000 miles in diameter) has a very much higher temperature than these, else also would it not melt the solid crust? and on the other hand we may not believe the nucleus has much less temperature than those named, else it would have abstracted heat from the fluid lava, and would have solidified it.

Hypothesis.

If we make a large hemispherical coal fire on the ground, it will not, perhaps, very badly represent a hemisphere of the earth. The late Professor Daniell, F.R.S., determined for us that the heat of it will be 1,141° F., that is to say of its centre. *The heat, also, at half the distance from the centre to the sides will be sensibly the same.* That is to say, the eye cannot detect that the fire approaches nearer to a *white* heat (which is the measure of its temperature) at the centre than at half the distance towards the sides. And it may be a question whether attempts at actual measurement would succeed in proving that the centre was the hottest. The comparatively cool outside of the fire would not badly represent the crust of the earth. Take, again, the case of a large mass of melted cast iron, run out into a mould, which the same authority has determined to be 2,786° F. The exterior surface in contact with the sand would immediately part with a portion of its heat and become solid; but *the centre part and the parts at half the distance thence to the sides would remain at* 2,786° *for a certain period.* The case does not appear to be more difficult if we venture to speculate on the refrigeration of the earth. Let it be supposed, then, as it has often been supposed before, that the earth with its waters, its atmosphere, and its gases, was originally a vast spheroid of vapour with the enormous temperature due to such a state. Let it also be supposed that the universal law of gravitation then prevailed, and that the body of vapour revolved on its axis, and circulated in an orbit, no matter of what form or dimensions, nor what was the nearest approach to the central body. The space traversed by our vaporous body in its orbit must have been of a lower temperature than the body itself, else the vapour could never have cooled into a fluid much less into a solid. After a short geological period, a comparatively thin stratum all over the surface of the spheroid would have so far cooled down as to become fluid instead of vaporous, *by which its specific gravity would be greatly increased,* and it would immediately fall like a shower of rain, the heaviest parts being foremost, along radii of the spheroid towards the centre of gravity. But it would fail to reach that centre, *because it would soon become vaporous again,* from a double cause, namely, from the heat it would absorb from the vapour by which it would have become surrounded, and by the conversion of its own rapid motion into heat. Very soon after, in due order, another, and another, and another shower of fluid would be precipitated towards the centre of gravity to be again, and again, and again, reconverted into vapour by the two combined causes. But this process could not be repeated for ever; the whole spheroid of vapour would part with more and more of its heat, and become fluid in process of time, and would consequently *diminish in volume;* and the showers of lava would descend nearer and nearer to the centre of gravity, which some of them would at length reach, and *there they would remain;* because they would be heavier than anything else, and would, in fact, be the commencement of the nucleus. This commencement of the nucleus we will call the end of the first stage of the process of conversion.

Note.—Some of Lord Rosse's beautiful drawings of nebulæ in *Phil. Trans. R.S.*, 1861, part 3, will well serve as diagrams, by their forms and textures and incipient nuclei, to illustrate this hypothesis. The following figures or drawings are especially referred to, viz., H 15, H 262, H 311, H 327, H 1,111 and 1,113, H 1,946, and H 2,075. Whether there is any real resemblance in the nature and present condition of any of those vast systems to the hypothetical primitive condition of our earth is more than I know.

To proceed with the hypothesis, which is by no means identical with Sir W. Herschel's nebular hypothesis:—A long geological period would elapse before this stage of the process was reached, and a further long period may perhaps have elapsed before the remaining parts which are *now* either solids or fluid lavas, *had all changed from the vaporous to the fluid condition,* and the earth had become reduced nearly to its present dimensions. By the time this second stage had been accomplished, *the rapid circulation which has been sketched would have brought all except an extremely thin shell of the surface to a uniform temperature of about* 3,000° *or* 3,300° F.; or to something else not widely differing from that amount. And our spheroid of fluid lava would then begin, as a third process, to cool on the outside and form a *cavernous* crust. Emphatically a "cavernous" crust, because those parts which contained non-lithia micas would solidify at higher temperatures than those others which consisted of felspar, for example*:—Must not the immense nucleus of the earth therefore even now be fluid lava, and of not greatly higher temperatures than those named, and consisting of ingredients of a certain average specific gravity such that the average specific gravity of the whole *present* spheroid would of necessity be about 6·565, as the Astronomer Royal eliminated from his experiments at the Harton mine, which cannot be far from the truth? His figures indicate a specific gravity intermediate between the gravities of the commoner metals, viz., copper, brass, iron, tin, and zinc, which all range between 8·91 and 7·19; and those of the stones, viz., marble, granite, Purbeck, Portland, Bristol, millstone-grit, and sandstone, which all range between 2·72 and 2·143. We may not, therefore, suppose that the amount of metals (especially not of the precious metals) contained in the nucleus, is relatively great, for that would make the specific gravity too high. And we may not even suppose that the nucleus is composed of material as heavy as melted stone at

* Lyell's "Principles of Geology," 1853, p. 427.
† Brit. Assn. Report 1847, pp. 51 and 54.
‡ Sir H. de la Beche's, "Cornwall," &c., p. 191.

* We shall see in No. 9 following, in next month's paper, that when granite is passing from a plastic to a solid state, a contraction of more than 10 per cent. takes place, which would leave a cavity of that dimension. We shall see also plenty more reasons why there must be cavities.

the surface of the earth, because the pressure due to the enormous depth down to the centre of gravity, would *compress*, and make even that too much. Apparently we are compelled to suppose that some such light material as *pumice* constitutes an important part of its bulk, and we actually know, in point of fact, that pumice *is* an abundant product of volcanoes.

This hypothesis of a uniform heat of the earth's vast nucleus, is most favourable to the fact of the absence of all appreciable secular refrigeration since the time of Hipparchus, a period of 2,000 years. If such refrigeration had occurred, the earth's bulk would have diminished, and its revolution on its axis would have been performed in a shorter time, that is to say, the day would have shortened. Whereas astronomers know that the length of the day has not diminished by 1-100th of a second within that period.

Observe, in the following evidences, how closely and inextricably *all* the species of natural disturbances of the earth's crust are commingled and combined together, as if they were all produced by one and the same cause. And how very probable that *steam*, produced by the contact of lava and water, is their cause!

VIII.

ACTIVE VOLCANOES BENEATH THE SEA MUST NECESSARILY PRODUCE BOTH STEAM AND EARTHQUAKES.

40. The Gulf of Santorin in the Grecian Archipelago has been for 2,000 *years a scene of active volcanic operations.* The Gulf contains three volcanic islands, namely, Old, New, and Little Kaimeni. Pliny informs us that Old Kaimeni rose above the water 186 before Christ. It was increased in size by other eruptions in A.D. 19, 726, and 1427. In 1573 another eruption produced Little Kaimeni. In 1650 a submarine outbreak gave rise to a shoal, which was surveyed in 1848 by Captain Graves, and found to have 10 fathoms of water over it, the sea deepening around it in all directions. This eruption lasted three months, covering the sea with floating pumice. *At the same time an earthquake destroyed many houses* in Thera.—*Principles*, p. 441.

SUBMARINE ERUPTIONS IN VERY DEEP WATER.

41. "In the 'Nautical Magazine' (says Sir Charles Lyell) for 1835, p. 642, and for 1838, p. 361, and in the 'Comptes Rendus,' April, 1838, accounts are given of a series of volcanic phenomena, earthquakes, troubled water, floating scoriæ, and columns of smoke, which have been observed at intervals since the middle of last century, in a space of open sea between longitudes 20° and 22° west, and about ½° south of the equator."—*Principles*, p. 436.

NOTE.—I find this situation is more than 600 miles from the nearest land, which is the small island of Ascension, and the sounding is 2,800 fathoms, according to Lieut. Maury's chart. The hydrostatic pressure would be 7,496lbs., or about 3½ tons per square inch on the bottom. Steam, however, overcame this pressure, and in addition gave shocks to ships on the surface, as will be seen in the two next evidences. And the mass of fire must be very great not to have been extinguished by the vast volume and pressure of water.

42. "Submarine volcanic action near the equator has been for some years going on. We have now two accounts of it observed by ships, but a few miles apart from each other—the *Dallas*, Captain Wikauder, and the *Melbourne*, Captain Cowie—on March 20th, 1861. The latter says:—'We were startled by a heavy and loud rumbling noise, and at the same time felt the ship tremble from stem to stern, which lasted four or five minutes. The noise resembled more the low grumble of distant thunder than the harsh, grating noise produced by the ships taking ground. The *Dallas* lost her false keel by the collision.'"—*Illustrated London News*, Aug. 17, 1861, p. 157.

43. "Feb. 9th, 1835, at 10 hrs. 45 min., on board the barque *La Couronne*, of Liverpool, a shock was felt at sea in 0° 57′ south latitude, and 23° 19′ west of Greenwich." See "Comptes Rendus," t. 6, p. 514, as quoted by Lieut. Maury in "Physical Geography of the Sea."

NOTE.—From Lieut. Maury's chart the sounding would be about 3,000 fathoms, and the inertia of the water 8,031lbs., or more than 3½ tons per square inch.

44. *An earthquake at sea.*—Capt. P. E. Lawson, of the barque *Viking*, of Sunderland, reports that on the 16th ult., at 2 p.m., while in latitude 36° 18′ north, and longitude 2° 32′ west, (which position is in the Mediterranean 165 nautical miles east of Gibraltar, opposite the Bay of Almeria) he experienced a severe shock of an earthquake, as though the ship had taken a shoal of rocks; and so severe was it that the vessel was shaken with great violence, and everything on board was similarly affected. This lasted above five minutes, when the shock subsided, and the vessel resumed her course, nothing the worse for the severe shaking she had undergone. The weather at the time was beautifully fine, and the water remarkably clear. —*Record Newspaper*, Aug. 21, 1865.

SUBMARINE ERUPTIONS AT LESS DEPTH.

45. "On the 20th Nov., 1720, a burning island was raised out of the sea near Tercera, one of the Azores, at which place several houses were shaken down by an earthquake which attended the eruption. This island was about three leagues in diameter and nearly round; whence it is manifest that the quantity of pumice stones and melted matter requisite to form it, must have been amazingly great."—Rev. John Michell, *Phil. Trans. R.S.*, 1760, p. 452.

46. Another example of the same kind happened at Manilla in 1750. This, also, was attended with violent earthquakes, to which that island, as well as the rest of the Philippines, is very much subject.—*Ibid.*

47. Barren island in the Bay of Bengal, east of the Andaman Isles, in lat. 12° 15′, when seen from the ocean presents on almost all sides a surface of bare rocks rising with a moderate acclivity towards the interior; but at one point there is a cleft by which we can penetrate into the centre, and there discover that it is occupied by a great circular *basin filled with the waters of the sea*, and bordered all round by steep rocks, in the midst of which rises a *volcanic cone very frequently in eruption.—Principles*, p. 466.

48. In 1835, a submarine *volcano* broke out near Bacalao Head, Isle of Juan Fernandez, about a mile from the shore, in *sixty-nine fathoms water*, and *illumined the whole island* during the night.—*Principles*, p. 454.

49. In the Aleutian Archipelago eruptions are frequent, and about thirty miles north of Unalaska, near the Isle of Umnack, a new island was formed in 1796. It was first observed at a *point in the sea from which smoke had risen. Flames* then issued from the new island which illuminated the country for ten miles round; a *frightful earthquake* shook the new formed cone, and showers of *stones* were *thrown as far as Umnack.* —*Principles*, p. 352.

NOTE.—The *flames in the water* in the two last evidences cannot have failed to produce *steam.*

In 1806 another, and in 1814 a third, submarine island arose among among the Aleutian Islands.—*Principles*, p. 468.

NOTE.—There are vast tracts of submarine volcanoes. (See *Lyell's Principles of Geology*, p. 350, &c.

50.—Graham Island, off the south-west coast of Sicily thirty miles, rose in July, 1831, in 100 fathoms water, *steam playing an important part*, and disappeared again in three months. The following are a few details:

About a fortnight after the eruption was first visible, Sir Pulteney Malcolm passed over the spot in his ship and felt the shock of an earthquake, and the same shocks were felt on the west coast of Sicily—direction, S.W. to N.E. About July 10, John Corrao passed in his ship near the place, and saw a column of water 60ft. high and 800 yards in circumference, rising from the sea, and soon after *a dense steam in its place* rose to the height of 1,800ft. On his return from Girgenti on July 18, he found a small island, 12ft. high, with a crater in its centre, ejecting volcanic matter and immense *columns of vapour.* In August, there was a violent ebullition and agitation of the sea on the south-west side of the island, indicating a second vent not far from the surface.—*Principles*, pp. 432, 434.

There is a similar account in Milner's "Gallery of Nature," p. 376, &c.,

which says, in addition, that Admiral Sir H. Hotham sent an officer to report, whose account confirms the preceding statement. This officer particularly mentions the *vast volumes of pure white steam*, which tends to corroborate the opinion expressed in No. 8, that Sir William Hamilton's white cotton-like vapor was *steam*. We have had, and shall have, abundance of proof that Vesuvius ejects vast quantities of steam and boiling water.

IX.

EJECTIONS OF STEAM FROM EARTHQUAKES.

Are not the two following cases proofs that steam must be the cause of earthquakes?

51. At Deception Island, in Tierra del Fuego, where earthquake shocks are of most constant occurrence, there are no less than 150 *chasms* or fissures, *from which steam pours forth with a loud hissing noise.—Chambers' Edinburgh Journal*, Aug. 17th, 1861, p. 157.

52. Baron Humboldt says that *hot steam was ejected* during an earthquake in 1812, at New Madrid, in the valley of the Mississippi.—*Cosmos*, vol. 1, p. 209.

X.

EJECTIONS OF WATER AND OF MUD (WHICH IMPLIES THE PRESENCE OF WATER) FROM VOLCANOES. ALSO SINKINGS OF RIVERS AND OTHER WATERS.

Following are some additional evidences that steam issues from Vesuvius, and necessarily in vast quantity, for it becomes condensed into torrents of water, which descend the cone, and are as destructive as lava itself. Lava is generally ejected from volcanoes during eruptions, but is not always mentioned in these evidences, because the object now is to exhibit aqueous products, not molten matter.

53. "Not long before the eruption of Vesuvius in 1631, in one part of the plain (at the foot of the cone) covered with ashes, were three small pools, one filled with hot and bitter water, another salter than the sea, and a third hot but tasteless. In December, 1631, *great floods of mud were as destructive as the lava itself;* no uncommon occurrence during these catastrophes; for *such is the violence of rains produced by the evolutions of aqueous vapour*, that torrents of water descend the cone, and become charged with impalpable volcanic dust, and rolling along loose ashes, acquire sufficient consistency to deserve their ordinary appellation of *aqueous lavas*."—*Principles*, p. 374.

54. From *Gallery of Nature*, p. 781, we learn that:—"Among the peculiarities of Vesuvius the *emission of boiling water from its flanks*, has often been remarked; this is not uncommon with transatlantic volcanoes, together with torrents of mud—a compost of water and ashes—forming a fetid clay."

55. It is stated in the *Encyclop. Brit.*, vol. xvii., in an article attributed to Sir John Herschel, Bart., F.R.S., that "an *earthquake* happened in 1631 at Mount Vesuvius, which covered with lava most of the villages at its foot, and *sent forth torrents of boiling water*."

56. The following is so important and so full of significant facts, that it is quoted almost entire from *Principles* p. 430. At Galangoon in Java in 1822 there was a volcanic eruption. "In July, 1822, the waters of the river Kunir, one of those which flowed from its flanks, became for a time hot and turbid. On the 8th October following, a loud explosion was heard; the earth shook, and *immense columns of hot water and boiling mud*, mixed with burning brimstone, ashes, and lapilli of the size of nuts, were projected from the mountain like a water spout, with such prodigious violence that large quantities fell beyond the River Taudoi, 40 *miles* distant* (*sic*) .... It was remarked that the *boiling mud and cinders were projected with such violence* from the mountain, that while many remote villages were utterly destroyed and buried, others much nearer the volcano were scarcely injured. The first eruption lasted nearly five hours, and on the following days the *rain fell in torrents*, and the *rivers* densely charged with mud *deluged the country far and wide*. At the end of four days (Oct. 12), a second eruption occurred more violent than the first, in which *hot water and mud were again vomited*, and great blocks of basalt were thrown to the distance of seven miles from the volcano. *There was at the same time a violent earthquake* .... and in the night of October 12th, 2,000 people were killed."

* At a guess, there must have been some such a force as 800 tons per square inch at work on this occasion.

57. "In Quito, on July 19th, 1698, *during an earthquake*, a great part of the crater and summit of the volcano of Carguirazo fell in, and *a stream of water and mud issued* from the broken sides of the hill."—*Principles* p. 503.

58. The following is a remarkable case of the connection of a volcano with another mountain, and with an earthquake at great distances, and of the ejection of water. It is from the "Encyclop. Brit.," vol. xvii., p. 511. In 1797 *it was proved that the volcano of Pasto was connected with the volcanoes of Quito*. Black smoke had issued from Pasto for months, but *suddenly disappeared at the moment when the city of Riobamba*, 65 *leagues distant, was destroyed by a terrific earthquake*. The country round, namely 40 leagues from south to north, and 20 leagues from east to west, undulated with extreme violence for four minutes. Round the mountain every town was thrown down, and two cities buried underneath impending mountains. The base of Mount Tunguragua, near Riobamba, was riven asunder, and *poured out streams of water and mud which filled valleys 600ft. deep*. Suffocating exhalations were emitted from Lake Quilotoa, and, it is said, flames also. Violent shocks were felt for three months over a district 170 leagues from north to south, and 140 from east to west. The curious fishes (pimelodes cyclopum) were found in the ejected water of the volcano.

NOTE.—Much more than what we have called the "average" effects of volcanoes and earthquakes appears to have been in operation.

59. From the same volume we learn that, on March 26th, 1812, subterraneous thunderings were heard, the ground undulated, and at one shock the fine city of Caraccas was destroyed with 10,000 of its people. By this earthquake *the great Lake of Maracaibo had its level lowered*, and the *riven earth* at Valencia and Puerto Cabello *poured forth enormous torrents of water*.

60. "*Mud*, black smoke, and even flames were ejected at Messina in 1781."—*Cosmos*, vol. i., p. 209.

61. On May 7th, 1860, *several earth shocks* were felt at Myrdalen, a village in the southern district of volcano Kotlugia, after a rest of thirty-nine years. *Next day the volcano threw up an immense quantity of water*. There was a pretty heavy shower of ashes, accompanied by subterranean thunder.—*Athenæum*, July, 1860, p. 94.

62. Boussingault says, Chimborazo has ejected *masses of mud*, elastic fluids, and trachytic blocks.—*Cosmos*, vol. v., p. 335.

63. Next morning after the formation of Monte Nuovo, in 1538, an eye-witness says, the inhabitants of Puzzuoli were covered with a *muddy and black shower*, which continued all day.—*Principles*, p. 367.

Another account says, jets of red hot lava, large rocks, and sometimes *mud composed of a mixture of pumice, tuff, and water* were hurled into the air.—*Principles*, p. 370.

XI.

EJECTIONS OF WATER, OFTEN HOT, FROM EARTHQUAKES AND FROM RISINGS AND SINKINGS OF STRATA, AND FROM EARTHQUAKES COMBINED WITH VOLCANOES.

64. "*Hot water* was ejected *from an earthquake* in Catania in 1818."—*Cosmos*, vol. i., p. 209.

65. There was a *tremendous earthquake* in Peru in 1746, 200 shocks in twenty-four hours. A *volcano* in Lucauas *burst forth the same night*, and *so much water descended* from the cone *that the whole country was overflowed;* and in a mountain near Pataz three other volcanoes burst out, and frightful torrents of water swept down their sides.—*Principles*, p. 501.

66. In 1692, Port Royal, in Jamaica, with about 1,000 acres adjoining, sunk in one minute into the deep. In Clarendon precinct the earth gaped, and spouted up with prodigious force great quantities of water at twelve miles from the sea. In 1746 the ocean burst in upon the land,

when the barrier of land sunk into the sea; Lima was overwhelmed, and the present port of Callao formed. These convulsions were accompanied by eruptions of water and mud from several volcanoes among the Andes, many hundreds of miles distant.—*Phil. Trans., R.S.*, 1760, vol. xi., p. 469, and *Encyclop. Brit.*

67. The earthquake by which Jeddo was destroyed, in 1783, destroyed also twenty-seven other towns and villages, totally. Boiling rivers overflowed their banks, and at least 180,000 people are said to have perished. —*Quarterly Review*, Oct., 1863, p. 461.

Sir Rutherford Alcock, vol. i. p. 186 says of the same earthquake:— "Twenty-seven towns and villages were destroyed; *the rivers boiling and overflowing*, inundated the whole country to complete the work of destruction."

68. Humboldt says, a very striking proof of the origin of *hot springs* by the *sinking of cold meteoric water* into the earth, and by its *contact with a volcanic focus*, is afforded by the volcano Jorullo in Mexico. In September, 1759, *Jorullo was suddenly elevated into a mountain* 1,183ft. high. *Two small rivers* the Rio de Cuitimbo, and Rio de San Pedro *disappeared*, and some time afterwards *burst forth again as hot springs*, whose temperature he found, in 1803 to be 186·4° F.—*Cosmos*, vol. i., p. 219, and vol. v., p. 313.

69. In the afternoon of the day preceding the great Lisbon earthquake of 1755 the water of a fountain at Colares, twenty miles from Lisbon, was greatly decreased. On the morning of the earthquake it ran very muddy, and after the earthquake it returned to its usual state both in quantity and clearness. . . . This earthquake took its rise from under the sea (p. 458).—Rev. John Michell, *Phil. Trans., R.S.*, 1760, p. 463.

70. On Feb. 2, 1828, the whole island of Ischia was shaken by an *earthquake.* The *hot spring of Rita,* which was nearest the centre of the movement, was ascertained by M. Covelli to have *increased in temperature.* —*Principles*, p. 456.

XII.

VOLCANOES, EARTHQUAKES, HOT WATER AND INCREASING TEMPERATURE OF HOT SPRINGS, SOMETIMES ALL CONNECTED TOGETHER.

71. M. Abich has proved the connection which exists between the thermal springs of Sarcin, and the earthquakes which frequently visit the elevated districts in every second year. In October, 1848, an undulatory movement of the earth which lasted for a whole hour, caused the temperature of the spring, which is between 111° and 115° F., to rise immediately to a most painful scalding heat.—*Cosmos*, vol. v., p. 175.

72. Charpentier observed that the temperature of the sulphureous spring of Lavey (above S. Maurice, on the bank of the Rhone), rose from 87·8° to 97·3° F., during the Swiss earthquake of August 25th, 1851.—*Cosmos*, vol. v., p. 175, note.

73. A tremendous earthquake, which destroyed a great part of St. Domingo in 1770, caused innumerable fissures throughout the island, from which mephitic vapours emanated. Hot springs burst out where there had been no water before, but after a time they ceased to flow.—*Principles*, p. 494.

74. In the cases of Stromboli, Etna, the volcanoes of the isle of Bourbon, and Kiranea, in Owhyhee, melted matter of unknown depth, covered for the most part with a thin pellicle of scoriform lava, and emitting copious volumes of steam or gas, was perceived in the craters.—*Dr. Daubeny*, p. 662.

75. The violent earthquake which devastated Syria in January, 1837, was felt on a line 500 miles in length by 90 miles in breadth; more than 6,000 persons perished; deep rents were caused in solid rocks, and new hot springs burst out at Tabereah.

76. "The town of Chittagong, in Bengal, was violently shaken by an earthquake on the 2nd of April, 1762, the earth opening in many places, and throwing up water and mud of a sulphurous smell."—*Principles*, p. 494.

The following, especially the parts in italics, are very striking and significant. Has the water sunk so as to be now in process of conversion into steam?

EXPECTED ERUPTION OF VESUVIUS.

77. "In the townships under Vesuvius," says a letter from Naples, "I find an uneasy feeling prevailing, and a general expectation of an earthquake. The less educated classes say that as the cholera in 1856 was followed by an earthquake, so we may look out for another now. Among persons better educated, one said, 'I never go to bed without apprehension, and sleep with my door open.' The reasons for such apprehensions, when they are adduced, are these:—Vesuvius has long been dormant. Of late it has been making some ineffectual efforts to relieve itself, but nothing beyond a line of smoke by day and an occasional tongue of fire by night is perceptible. Then, *all round Vesuvius*, extending even to Castellamare, there is a *perfect dearth of water*, so much so that the arsenal of that place, which has always derived its water from mountain springs that have never failed even in summer, is now compelled to send to a considerable distance for water. Perhaps the most *startling fact* is the *depression of the sea all round the bay.* I have examined it at various places, and find that this *depression* is *at least two palms beneath the ordinary level.* We have certainly had a month's calm weather, but, still, this is scarcely sufficient to account for the fact now stated."—*British Press* (Jersey), Jan. 12, 1866.

Papers on this subject have appeared in THE ARTIZAN for January and February, 1864, and in June and November, 1865, as well as in January, February, and March, 1866. These, especially the five last, complete the case, which is, that steam is *the* cause of every species of natural disturbance of the earth's crust.

The paper in THE ARTIZAN for April will recite various reasons, more or less forcible—and old, or new, or newly put—why there *must* be cavities in the earth's crust. Several following papers will give various details which will prove incidentally that one or more such cavities must have existed to have allowed sinkings of two or three thousand square miles of land and more than 100ft. in depth, which have certainly taken place since Julius Cæsar's time, on the westerly coasts of France, more especially in the Channel Islands' seas.

INSTITUTION OF CIVIL ENGINEERS.

ON THE CRAIGELLACHIE VIADUCT.

By Mr. W. H. MILLS, M. Inst. C.E.

This viaduct was constructed for the purpose of carrying the Morayshire Railway over the River Spey, at Craigellachie, Banffshire, the engineers being Mr. Samuel (M. Inst. C.E.) and the author. It consisted of three spans of 57ft. each on the north bank, and one span of 200ft. over the main channel of the river, ordinary boiler plate girders constituting the former, and the latter being of wrought iron on the lattice principle. The piers and abutments were of solid ashlar Masonry, and the works were arranged for a single line of railway.

It was stated that the Spey was one of the largest and most rapid rivers in Scotland, and was also subject to sudden and heavy floods, the water sometimes rising 6ft., 8ft., or 10ft. in as many hours. It was about 110 miles in length, took its rise amongst the Grampian range, at an altitude of upwards of 1,100ft. above the sea level, and for 10 miles above the viaduct, which was situated 15 miles from the sea, its average fall was 14ft. per mile. No part of the river was navigable for boats, but it was much used for the conveyance of timber, which was floated down in rafts.

In designing the viaduct, it was necessary to provide an uninterrupted channel for the free passage of rafts, and to construct the piers and abutments so as to be able to withstand the blows and pressure from any blocks of ice or floating timber that might be brought down during floods. The channel of the river was at ordinary seasons 180ft. broad, and 4ft. deep in the centre. The height to the underside of the girders from the usual water level was 20ft. The bed of the river consisted of coarse gravel interspersed with large irregular boulders, overlaying a compact layer of gravel and clay. A timber pile cofferdam could not, therefore, be advantageously employed, and it was decided to use cast iron cylinder foundations for the main pier, small river pier, and main abutment, and thick beds of concrete for the small land pier and abutment. The cylinders in the main pier and abutment were 5ft. in diameter, and in the small river pier 4ft. 3in. in diameter. They were in two equal lengths, and formed, when bolted together, one complete cylinder 13ft. 6in. in length. Their size was sufficient to allow a man to work inside, the large boulders being broken up with wedges, and removed in pieces, with the excavated material. The operation of sinking the cylinders was carried on night and day, generally with four or five at the same time, and so expeditiously that the eighteen cylinders in the

main pier were fixed and filled with concrete in six weeks, and the fifteen cylinders in the main abutment, where a larger force was employed, in three weeks. There were eleven cylinders in the small river pier, and, in all cases, the lower edges of the cylinders were 13ft. 6in. below the bed of the river.

The general arrangement of the plates, angle irons, and T irons of the lattice girders provided for a free circulation of air to all the ironwork, facility for getting at the parts for cleaning and painting, and avoided any opportunity for the lodgment of water or snow. These girders were parallel throughout, and their depth was 17ft. 4in. The top and bottom members were T shaped, the width across being 3ft., and they were composed of horizontal plates, a vertical plate, and four angle irons. In the section adopted almost every portion of the iron was brought into effective work, and took part in the strain. A single system of lattice bars was used for each girder, consisting of angle irons varying in section according to position and relative strain. The main girders were 17ft. apart from centre to centre, and they carried the railway on the lower flange. The cross girders were of wrought iron 12in. deep and 4ft. apart, the rails being carried upon longitudinal timbers bolted to the cross girders. The lattice girders were held together laterally by five wrought iron diaphragms, securely fastened to the main girders at the top, bottom, and sides. The lattice girders and the plate girders for the smaller spans wese rivetted together at the main pier, and formed thus one continuous system. At the main pier the girders were bolted down to the masonry, while at the other piers and at the abutments the girders rested upon turned cast iron rollers.

The result of several experiments showed that the average breaking weight of the plates was 32·39 tons per square inch, and of the angle irons 24·16 tons per square inch. At the Government inspection with a moving load equal to 1 ton per lineal foot, the deflection of the main girders was only $\frac{7}{8}$ths of an inch, and there was no permanent set in any of the girders. The effective sectional area of the bottom member, deducting for cover plates, rivets, &c., was 70 sq. in., giving a tensible strain of 4·1 tons per sq. in. The effective section of the upper member, without deducting for cover plates, was 75·74 sq. in., which gave a compressive strain of 3·78 tons per sq. in.

The quantities of materials used in, the time occupied in the execution of, and the actual cost of the different portions of the work, were given in detail. It appeared that the excavation for the foundations was commenced in May, 1862, and that the viaduct was opened for public traffic in July, 1863. The total cost had amounted to £12,199, or equal to £29 10s. per lineal foot.

ON THE GRAND RIVER VIADUCT, MAURITIUS RAILWAYS.

By Mr. W. Ridley.

It was stated that the length of this viaduct, from abutment to abutment, was 620ft., and that this distance was divided into five openings of 116ft. each in the clear. The height from the level of the rails to the surface of the water was 129ft. 9in. Each pier was composed of two cast-iron cylinders, each 10ft. in diameter, resting upon masonry foundations, and filled with concrete, the works being for a single line of railway. Mr. Hawkshaw (Past President, Inst. C.E.) was the consulting engineer to the Government of Mauritius, and the contractors for these railways were Messrs. Brassey and Co., for whom Mr. Longridge (M. Inst. C.E.) acted as resident agent. In constructing the piers of this viaduct, cylindric rings 9ft. high were divided into five segments each, and were bolted together by internal flanges. The abutment on Port Louis side was built upon hard tufa, and No. 1 pier rested upon a rock projecting on the side of the ravine. During the excavation for the foundation of No. 2 pier considerable trouble was caused, owing to the pier being situated close to the edge of the river, and from the nature of the ground, which consisted of large boulders and fine river gravel, the water freely percolating on all sides. At first it was thought that the water might be kept out by a series of dams, but these proved insufficient, as the water found its way through the bottom in such quantities, that it became necessary to resort to steam power. In order to render the working of the pumps more effectual, the straight discharge pipes, which were 4in. in diameter, were tapered out at the discharge ends to $8\frac{1}{2}$in. The effect of this alteration was, that nearly twice the amount of water was delivered. The two pumps made 300 revolutions per minute, and discharged nearly 3,000 gallons per minute. It was next resolved that the foundation should be formed of blocks of concrete, and that sufficient excavation for one block only should be taken out at a time. Tarpaulins were laid in the bottom, and for 4ft. up the sides of the excavation, for the purpose of preventing the numerous springs of water from washing out the cement, and this plan was found to answer perfectly, five distinct blocks being thus successively laid. The foundation for No. 3 pier was of the same description as that of No. 2 pier, while No. 4 pier and the adjoining abutment were founded upon rock and hard tufa.

The segments for the first rings of each pier were lifted into their places by means of sheer legs and tackle, and in two cases the second rings also; but subsequently a mast, with a crosstree and struts, mounted on a frame inside the cylinder, and free to revolve easily when required, was employed. As each ring was completed, the mast, with its supporting frames, was lifted, the time occupied in effecting this being about four hours and a half. Eleven pairs of rings were thus placed on No. 1 pier, thirteen each on Nos. 2 and 3, and ten on No. 4. The heights to the top of the last ring on each pier were respectively 99ft., 117ft., 117ft., and 90ft. The weight of each segment lifted was 32 cwt., and one set of men in one day completed one ring and raised the mast.

Piers Nos. 1 and 4 were filled with concrete from the adjoining abutments. A single contractor's rail, weighing 23lbs. per lineal yard, rested on two frames, that on the abutment being higher than the one on the pier, and on this rail a box with a false bottom was made to travel, by a sheave rolling over it. The box contained 7 cubic feet, and weighed, when filled, $8\frac{1}{2}$cwt.; as soon as the contents were discharged, the box was drawn back by a rope. At piers Nos. 2 and 3, the concrete was lifted by means of an endless ladder, of iron, worked by a small engine. At every alternate joint was fixed, by angle pieces and diagonal stays, a light deal shelf, sufficiently large to hold a basket containing nearly a cubic foot of concrete. When these baskets arrived at the tops of the piers, they were lifted off and emptied, and were returned on the undersides of the shelves. By the former method 50 cubic yards were completed daily, whilst by the endless ladder about 40 cubic yards were deposited at the same time, with one hundred men working at each. The concrete was carried to a height of 3in. above the tops of the cylinders, and consequently bore the whole weight, the cylinders merely serving the purpose of a casing, and preventing the concrete from crushing laterally.

The girders were sent from England in sections of about 12ft. long, which on arrival were transported to the Mahébourg side of the river, and were riveted together in lengths of 36ft. to 48ft. A gullet was here excavated to the level of the abutment, and extending backwards to a distance of about 280ft.; it then rose at a slope of about 1 in 5 to the formation level. In this gullet the first lengths of girders were to have been built, and as they were pushed forward, the succeeding sections were to be brought down the incline and added on. The arrangement for launching the girders was, however, considerably modified in England; but this modification, simple and effective as it appeared to be, and good as it was theoretically, practically proved a failure, and had eventually to be abandoned. The original plan was then resorted to. A line of flat-bottomed permanent-way rails, laid on longitudinal timbers, resting on cross sleepers, was placed under the centre of each girder. At every 12ft. a balk of timber, forming a skid, was placed transversely across the rails, and the girders were wedged up upon these balks. On the undersides of these balks, and over that part which would bear upon the rails, a thin plate of iron was fixed by two bolts, the heads of which were flush with the surface of the top, whilst the nuts projected underneath, and came up close to the inside edges of the rails, acting as guides to keep the girder in line when travelling. When the girders were ready to be moved, the rails were well greased, and men were placed at the ends of each skid with sledge hammers to keep striking it to prevent sticking, as well as to assist in starting. The rails were laid throughout the gullet, to within 5ft. of the face of the abutment, the underside of the rails being level with the surface of the masonry. When the skids arrived at the end of the rails they dropped, and were removed. On the top of the bed plates, the bearing plates for the permanent expansion rollers were bolted. These plates were tapered off at the ends, so as to allow the rollers to enter and to pass freely in and out. The latter were linked together, and after they travelled over the plates were taken out and returned, and linked on to the rollers just entered, and were gradually drawn in under the girders. Short keel pieces were followed up on the rollers, as the girders advanced, by men stationed on a scaffold. The launching was accomplished by means of powerful tackle and winches, and was so effectual that in one day the girders travelled 12ft. every fifteen minutes; subsequently they were advanced 108ft. in four hours, and the last span was completed in six hours and twenty minutes, the entire length of the girders, 630ft., moving quite freely. The roadway girders, plates, and permanent way were then laid, and in fourteen days after the launching was finished trains were running over the viaduct. The girders were fixed to the centre pier, while they rested upon rollers at the other piers and at the abutments, and so were free to expand and contract. The total weight of the superstructure was 560 tons, of which the roadway weighed 147 tons, and the total weight of ironwork in the piers, including bed plates, expansion rollers, &c., was 933 tons.

Feb. 6th, John Fowler, Esq., President, in the chair,—eleven Members and twenty-one Associates were declared to have been duly elected, including in the former class Mr. Charles Robert Atkinson, Dublin; Mr. George Rowdon Burnell, Bedford Row; Mr. Francis Fowler, Finsbury; Mr. Charles Douglas Fox, Spring Gardens; Mr. Henry Gale, Westminster; Mr. William Bourne Lewis, Westminster; Mr. Robert Aspland Marillier, resident engineer to the Hull Dock Company; Mr. William Mason, chief assistant engineer for railways in New South Wales; Mr. Frederick Thomas Turner, Westminster; Mr. Thomas Penn, Deptford; and Mr. Alfred Harris Vaux, East Indian Railway, Calcutta. The Associates elected were Mr. Henry Purdon Bell, resident engineer, Canal del Jarama, Spain; Mr. Robert Broad, the Horseley Works, Tipton; Mr. John Brown, Great Yarmouth; Mr. Robert Harvey Burnett, resident engineer and locomotive superintendent of the Metropolitan Railway; Mr. Thomas Cordington, Norland Square; Mr. Charles Campbell Downes, chief resident engineer to the Quebrada Land, Mining and Railway Company; Mr. Francis Stacker Dutton, agent-general for South Australia; Mr. Samuel Tate Freeman, Amsterdam Canal Works; Mr. Charles Frewer, Secretary to the Governor and Company of Copper Miners in England and Ireland; Mr. Easton Gibb, Aberdeen; Mr. Charles Gilpin, M.P.; Mr. William Vernon Harcourt, Q.C.; Mr. William Harrison, Bank Foundry, Blackburn; Mr. Edward Barber Rumble, East Indian Railway, Cawnpore; Mr. Frederick James, resident engineer of the Douglas, Ramsay and Peel Breakwaters; Mr. William Harrington Lucas, Belgrave Street, South; Mr. Edward Monson, surveyor and superintendent of the Water Works to the Halstead Local Board of Health; Mr. Frederick Newman, Long Ashton; Lieutenant-Col. P. P. L. O'Connell, R.E., consulting engineer for railways to the Madras Government; Mr. Joseph Robinson, Ebbw Vale Company; and Mr. Henry Wyndnam, Westminster.

Lancashire Files.—The Lancashire Steel Company have issued the following:—"We beg to advise you that owing to an advance in wages of 10 per cent., which we have conceded to our workpeople, our discount off the Sheffield list for new files will be reduced 5 per cent. until further notice. The same alteration applies for re-cutting files."

INSTITUTION OF ENGINEERS IN SCOTLAND.

(With which is incorporated the Scottish Shipbuilders' Association.)

ON THE CONSTRUCTION OF IRON VESSELS.

By Mr. James Lyall, jun., Sunderland.

It is an existing necessary evil in our modern wrought iron structures, that plates requiring to be fastened together must be perforated that they may be united into one complete whole, for as a natural consequence, that part of the plate so treated must be reduced in strength in proportion to the number and size of holes perforated, whether the same be done by drilling or punching; therefore all unions made by rivetting never can be equal in structural valve to the entire plate, by at least the sectional area of the holes in the line furthest from the butt or joining. This objection may, to a great extent, be got rid of by a little reflection and care in arranging the number of holes necessary, and increasing the width of the butt strip, when such can be done, and by substituting a superior quality of iron for butt strips; or by making them thicker, when the planting is of the thinner class, the strength through the line of holes next the butt may be maintained when it is necessary to pitch the holes closer, for the purpose of making the seam water-tight.

It is also essential in uniting the parts of a structure together by riveting, that the rivets be of the requisite form and size to suit and fill the holes tightly at all parts. The best mode of accomplishing this has been the subject of much discussion among engineers. Many advocate drilled holes, some prefer reaming them out after they have been punched, while others consider punching the superior plan. The author is of opinion where plates are regularly punched from the proper sides, so that the smaller diameter of the holes shall adjoin each other in their respective plates, no mode at present practised can surpass punching.

It must certainly be admitted that a pin or rivet in its cold state can be made to fit a parallel smooth hole better than it could a hole made by the punching machine, but the circumstances are altered when red hot rivets are substituted, as by the aeid of the hammer or revitting machine they may, while red hot, be forced into the inequalities of unfair and very rough holes, and I think the rough surfaces which punched holes present, assist to increase the adhesion of the rivet with the plate.

Moreover, so long as heated rivets are used, drilling holes would be but a useless expenditure of money, seeing that by the quickest mode of drilling, a greater expense wonld be incurred over punching an equal number of holes having a common diameter and depth, and it has yet to be seen that the rivets would fill the holes, even when they are drilled, as the holes require to be made larger than the normal size of the rivet, to allow for its expanding when heated. So it would, under the most favourable circumstances, in a parallel hole only fill that part near to the head in course of formation. This defect woald be experienced to a much greater extent when three or four thicknesses had to be rivetted together; and would apply also to punched holes, but might be obviated without incurring additional expenses further than obtaining and supporting a few more punches and dies. When it is required to rivet several thicknesses of plate together, a hole of an uniform taper may be obtained by having a separate punch for each plate; and we would then be in possession of a mode of fastening equal, if not superior, to the fairest hole which could be drilled for the reception of a rivet.

In boring through a number of plates there is the further objection that the drill produces burs on the inner surface of each plate, and if these be bolted together, in a verticle or slanting position, the borings get between the adjoining surfaces, to rid them of which it is necessary to disconnect and in some cases remove the plates after have have been drilled; and then it is not to be expected the plates will be replaced exactly in the same positions as they were when drilled. Not that it cannot be done; but it is useless to expect that this class of workmen will exercise the same care as those engaged at a finer department of engineering work.

Drilling, on the other hand, has the decided advantage of being accomplished with the minimum deterioration to the plates. This fact has been borne out "in a series of experiments made many years ago by Mr. Fairbairn; the mean tensile strength of seven specimens was reduced from 52,486lbs. per square inch before punching to 41,590lbs. per square inch of solid iron left between the holes after punching, more than 28 per cent. of the strength of the iron being destroyed by punching, a loss distinct from that of the metal actually punched out."

The tieing and stiffening, as well as the strength of the shell, and the fastening by which it is connected together, and to the frame work, are all more or less subject to changes according as the vessel approaches to the form of a sphere or assumes that of a parallelogram, or other figure bounded by straight lines, and with the relative proportions of the same, while to both should be given a greater power of resistance at those parts which are subject to greater pressure from their greater depths.

It is here, I think, a mischievous mistake is made by stopping short the bilge stringers towards the fore and after ends, where, from the forms of our wooden vessels, and especially steamers, these parts have less power to resist the heaviest lateral strains, and hence that working called "panting," experienced to a considerable extent in the "peaks" of steamers going at high velocities, on draughts ranging from 16ft. to 22ft. water. Although the after end may not be subject to panting from the same cause as those producing it in the "entrance," yet in screw steamers it is of great importance that the "run" be as well tied and stiffened, that it may be a check to the vibration so much felt on board many of our screw stermers. If these can be lessened by a little outlay at first, it is gain in the end, even where the comfort of passengers and the preservation of valuable cargoes, are not taken into consideration, as where there is that liability on the part of a structure to work, there is, so long as it continues a costly and irreparable evil.

Now this panting action at the ends of sharp vessels, is principally confined to that class which require to be immersed to a considerable depth in a rising wave, before displacing a sufficient volume of water to become buoyant, and as it is this immersion, with its alternate releases, which greatly augments this panting action, intensified by the high speed at which the vessel is going, it is requisite that this weakness be met, and the working prevented by placing material of a suitable form, and capable of uniting, and extending over that portion of the vessel subject to the action complained of. The fuller vessel, although able to carry more in the ends, has, with the increased capacity, a greater displacement and consequent buoyancy, and therefore cannot be immersed to so great a depth as her finer opponent, nor yet so frequently in a given time, her speed being less than the other; besides, the rounded form of her ends is better suited to bear a greater lateral strain with less injury to her structural properties. It might, therefore, be questioned whether, with the same or even less lateral stiffening in the ends, the fuller vessel could not perform her work through a given time with less injury than could be obtained from the finer vessel.

The strain which exposes the great weakness in long iron vessels is that to which they are subjected when accidentally caught in the middle or by the ends with the greater part unsupported, as in the narrow part of a river or on a submerged bank or rock, or when one of the ends, for a considerable length, may be overhung in a place where there is not at all times sufficient water to float the suspended part and prevent the strain, due to the weight of that part with the cargo it contains and its length affecting the upper works of the vessel. These are very unfrequent occurrences, it is true, but is it not the duty of the naval constructor to provide—so far as is within his power—for such emergencies? These strains, although of a shorter duration—are the same when the vessel is "pitching and "scending" in a heavy sea, and perhaps, for the duration of each rise and fall, are far more severe—the strain which is produced by the weight and length of the suspended part, and the cargo it contains, being now aggravated by the velocity at which it is raised and the sudden shocks met with in its descent.

The straining of vessels does not at all times act in a vertical direction, as in a common girder, but at an angle due to that at which the vessel may be sailing while subjected to those strains. It therefore becomes a matter of equal importance to have the sheer or mouth strake, as well as the deck stringers and ties, of a superior quality of material, possessing a high elastic limit, and also the best arrangement of fastening known, so as to obtain the greatest possible strength which can be had with the material disposed in this part of the structure. If it were possible to connect the butts of the outer thickness or strake without reducing that of the inside strake, such a method would most unquestionably be of the highest importance to the strength of the vessel; but as it has to be rivetted through the inside strake, which becomes the butt strip, there is a great deal of unnecessary weight carried in the upper parts of such vessels, which is really doing no good to the tensile strength of that part. An extra butt strip is sometimes put on the inside of the inside strakes at such parts, by which the rivets pass through three thicknesses, the two inner of which are but butt strips for the outside one, and gives rise to a new evil in a structure exposed to the heaviest tensile strains, as the material is now fastened to the ends of rivets of more than ordinary length for their diameter. Could not the same strength be obtained by substituting a better class of materials for the sheer strake; or by using butt strips only, but of a size sufficient to form the liners of the adjoining frames to those between which the butt is, whereby the best possible arrangements of rivets could be made, supposing the butt strips to be of a quality having a tensile strength equal to the best manufacture?

According to Mr. Fairbairn's article on the strength of iron vessels, in his valuable work, "Useful Information for Engineers," the upper works of our mercantile marine are very far below the requirements necessary to meet such contingencies as we have already supposed; being suspended either by the middle, the ends, or with one end overhung, and not sufficient water at all times surrounding it to prevent the upper works being strained to their ultimate destruction; and in showing how the required strength might be obtained, proposes to place longitudinal cells or box girders in the line of upper deck beams. The impossibility of having the inside surfaces of these girders periodically examined and painted is a great disadvantage, and one likely to stand in the way of their ever being adopted as a means of strengthening the upper works of vessels. A modification of the same might, however, be adopted—if such an arrangement should be desired—consisting of longitudinal girders of the H section, of the same depth as the athwart-ship beams, the ends of which would butt against the sides of the longitudinal girders, and be rivetted thereto by longitudinal plates on the upper and under sides, of sufficient width to allow of their being securely fastened together.

But it would appear in this, as in nearly all engineering matters, each constructor has his own opinion as to what is a sufficient section of iron to effectually resist the "breaking" of a ship when exposed in the manner already described.

Mr. John Vernon, in a very elaborate paper on this subject, read before the Institution of Mechanical Engineers at Liverpool in 1863, showed that the strength of an iron ship of 1,200 tons, built to take the highest class obtainable, was sufficiently strong to enable her to meet any of the above emergencies without being injured.

To take the same example as that adduced by Mr. Vernon—and first, let the vessel be resting by the ends, with the middle unsupported, and the distance between the supports as given 185ft. The sectional area in tension, which is made up on the assumption that all the strakes of side plating are effective to resist tension in proportion to their respective distances from the neutral axis is 547 sq. in. The weight of the ship is 758 tons, that of the cargo 1,945 tons, making a total amount of 2,703 tons. The length unsupported being divided into fourteen equal portions, the respective cargo capacities or loads of these are in the proportions of 11, 20, 23, 23, 22, 14

respectively, proceeding from the stern to the bow. The result obtained by taking a mean effect of these several loads at the centre of the vessel, is that the strain produced at the centre by the distributed load amounts in this case to 74 per cent. of the total load instead of 50 per cent., or one-half the load, as would have been the case if the distribution of the load had been uniform throughout the entire length. Hence the total distributed load carried being 1,945 tons, as ascertained above, the equivalent centre load will be in this case 74 per cent. of that amount, or 1,439 tons; and the additional weight of the vessel itself, 758 tons, may be considered as equivalent to a load of one-half the amount, or 379 tons at the centre, making together a total load at the centre of 1,819 tons, one-half of which, or 909 tons, is acting at each end by tension on the lower part of the vessel, with a leverage ot 92½ft., or half the length of the unsupported portion of the vessel. Following this up we have 909 tons, the weight acting at each end by tension into 92½ft., the distance at which this load is supposed to act from the centre, equal to a tension of 84,082·5 tons, to resist which we have 547 sq. in., at a distance of 9ft. from the neutral axis. Now, a double riveted joint is only equal to about 14 tons per square inch of section when the plates are of a quality capable of bearing 20 tons per square inch, and as the vessel under consideration would be double riveted, the value of each square inch of section must be allowed to be the same as that of the double riveted joint. We have, therefore, 547 square inches, into 14 tons, into 9ft., equal to a resistance of 68,932 tons, but showing a deficiency of 5,160·5 tons, or about 369 square inches, at the same value—14 tons per square inch—and this, after the side plating and lower hold stringers have been taken into the calculation. Mr. Vernon, however, meets this by setting down 17 tons per square inch of section as the tensile strength.

Let it now be supposed that the strain is thrown upon the upper works of the vessel by its being suspended at the ends and resting in the middle; using the same data as Mr. Vernon, we have the load at the end of the vessel amounting to only 44 per cent. of the total load, instead of 50 per cent., or one-half, as would have been the case if the load had been uniformly distributed through the entire length. With 45 per cent. of the whole weight carried, which is 1,945 tons, we have 856 tons, in addition to which there is the whole weight of the vessel, one-half of which acts in conjunction with 44 per cent. of the whole load, or 856 tons, making a total of 1,235 tons, one-half of which, or 617·5 tons, is acting at each end by tension upon the upper works of the vessel. Let this load be supposed to act at a distance of 92½ft. from the centre on each end, by which a strain of 57,118 tons will be produced. This, as before, is obtained by the load 617·5 tons into the distance at which it acts from the centre of the vessel to be resisted by 275 square inches—obtained as before in the bottom part into 16¼ft.—the distance from the neutral axis, which, taken as before at 14 tons per square inch for double riveting, gives 275 × 14 × 16¼, equal to about 62,562 tons, showing 5,444 tons above what is required for such an emergency; but this 275 square inches of section includes the side plates from the neutral axis, as well as the stringers., ties, and angles of both decks, and the sheer strakes. Where the centre of strain is not the centre of gravity of the material intended to resist that strain, the latter never can impart its full value to the structure of which it forms a part. Hence it will be objectionable to include the vertical plates on the side of a vessel below a given depth under the main or other deck under which the principal fastening is, and above a given height over the keel in vessels of ordinary dimensions.

Mr. Vernon has, however, made allowance for the above defect, by reducing the value or number of square inches in every strake in proportion to its relative distance from the neutral axis. When the way in which the upper works and bottoms of vessels are affected when under strain is considered with the elastic limits of wrought iron, and that in "ship plates" this property is very limited, it may be questioned whether any of the plating under the sheer strake and that adjoining it can be said to unite with the stringers and the plates in resisting any strain to which they may be subjected before these have been strained beyond their elastic limits, even when the strain is transmitted in an oblique direction, and in view of the limited extent of this latter property, the author does not think it admissable to estimate a number of vertical strakes on different planes, as if they were laid in horizontal layers, or of a shelved construction, the position most efficacious to resist tesion, as is done by taking the centre of gravity of each strake, and considering the whole area of the same to act at their respective distances from the neutral axis. If it were not for this and the defective mode of arrangement, how is it that so many fine vessels have been torn asunder when so exposed? Is it to be wondered at, after such calculations have been made, in which the highest credit is given to the material, in the manufacturing as well as uniting of which together, so many hidden flaws are never detected. This practical test should show that instead of a sufficient or surplus strength, there has been a very great deficiency.

A structure subjected to continued applications of a load exceeding one-third of its breaking weight will ultimately fail if these are very numerous. It is not difficult, therefore, to see that a vessel which has been at work for some years may be impaired in strength by the strains it has undergone during that time; and that in its being exposed to a strain of longer duration, in the way which we have already supposed, the breaking of the vessel is but the completion of a work which for some time has been in progress. A vessel at sea is never exposed to strains produced by the same length of overhang as that at which the foregoing calculations are made, but here the strain is a gradual one, whereas that when the vessel is pitching it is greatly augmented by the velocity of each rise, to an extent which will make it very severe on the parts in tension, supposing the suspended part be very much shorter.

As the value of any tie is proportional to the sectional area of the rivets uniting it to the parts tied by it, it would appear unnecessary to tie the deck or any other part of a vessel by lengths of iron placed at any other angle than a right angle to the beams, or parallel to the length of the vessel. If the sectional area of the rivets by which the ties or bracings are united to the beams are equal and extend over a certain part of their length, might not, therefore, the material used as diagonals be annexed to the present tie plates, and united with them in overcoming any tensional strain to which the upper works may be exposed, and at the same time overcome the zig-zag action imputed to iron vessels? If this view be a correct one its adoption would give more satisfactory results, with less cost than can be obtained by the present use of diagonals.

In the former days of wood shipbuilding, a rise was given to the ends of the vessel to hide any appearance of "hogging." This sheering of the decks and bulwarks of a vessel in no way increased her strength as a whole; but on the contrary, weakened that part which was shallowest, although it gave the appearance which was sought. In iron vessels this practice had been very considerably lessened by a few constructors; and so far as the strength of the vessel is concerned, it is perhaps to be regretted that these are but a few; for as long as the practice of sheering the upper decks, on which the principal fastening is arranged, is followed up, this fastening will be defective in imparting its full value as longitudinal ties, and even the stringers will be similarly influenced to prevent them acting in perfect unison with the sheer stakes when these are subjected to tensional strains, as before the ties can come into tension at the lowest part of the sheer they must be in the same plane; while the sheer strakes, which are prevented the same liberty of action by the rigidity of the deck beams, are resisting the strain by which they may be stretched to destruction before the deck ties exert anything like their full power; and if the vessel be strained in the reverse way, by being suspended from each end, the deck will be subjected to compression; but instead of the area it contains being usefully employed in assisting the bottom of the vessel—now under tension—it only increases it by the strain from the middle of the deck being transmitted through the hold stanchions—the results of the downward inclination at that part of the deck given by sheering. There are certain advantages obtained from giving sheer to a vessel, such as improving her appearance, when it has been properly carried out, and adding a degree of comfort when at sea; but could not this be accomplished by sheering the upper works only, excepting the deck, which might be made straight from the stem to the stern. By this mode not only the united action of all the material intended to resist the strains to which it is subjected, but with it would be insured a greater concentration of the weight over the most buoyant part of the vessel by lessening the carrying capacity of the ends, and curtailing the lengths of poops and forecastles, which by the proposed mode would be more lofty and better ventilated; besides affording, in many cases, as much passenger accommodation as the present mode. It would also give greater facilities in constructing the vessels, as in laying down the same, but one line and weight would be required to mark the beams firm, besides preventing mistakes, resulting in irregularities in the sheer lines of the beams, and thereby produces a superior class of work.

ON THE DETAILS OF WATERWORKS.

(*Illustrated by Plate* 297. *Continued from page* 35).

APPENDIX.

In Plate 297 we illustrate the circular filter bed constructed at the Hull Water Works, as an example of structures of this kind.

Fig. 1 is a half plan of the filter bed, showing the radial drains which collect the water from the filtering material, and convey it to the centre shaft D, from whence it is drawn off through the culvert B. The radial drains are made with open joints in the sides to admit the water, they terminate at their outer extremity in a circular channel, on which at intervals are placed air pipes, E E.

Fig. 2 is a half plan of the filter bed, with the filtering material superpose. A shows an open cut communicating between the filter bed and reservoir.

Fig. 3 shows a vertical section of one of the air pipes, and part of a radial drain, and of the wall and bottom of the filter bed. The line marked A indicates the water level of the water, B the summer level on extraordinary occasions, C the level to which the water might possibly be reduced; D level of top surface of sand, E level of top surface of gravel.

Fig. 4 shows a section through the open cut (A, fig. 2), taken between the culvert and the reservoir.

Fig. 5 shows a section through the open cut taken between the culvert and the filter bed.

Fig. 6 shows a section taken through the culvert.

Fig. 7 shows an enlarged view in part section, of a portion of the circular channel running round the inside of the filter bed, and its junctions with the radial drains.

Fig. 8 shows, in part section, an enlarged view of the central terminations of the radial drains, also the central shaft D, and a portion of the culvert B.

The diameter of this filter bed is 267ft. 6in.; its depth to the surface of the gravel, 10ft.; the depth from the winter water level to the surface of the sand being 8ft. The radial drains are internally 4½in. wide, and 3in. high.

HULL WATER WORKS.

PLAN AND DETAILS OF FILTER BED.

0 50 100 200 300 400

Scale of Feet

Fig. 1. Fig. 2

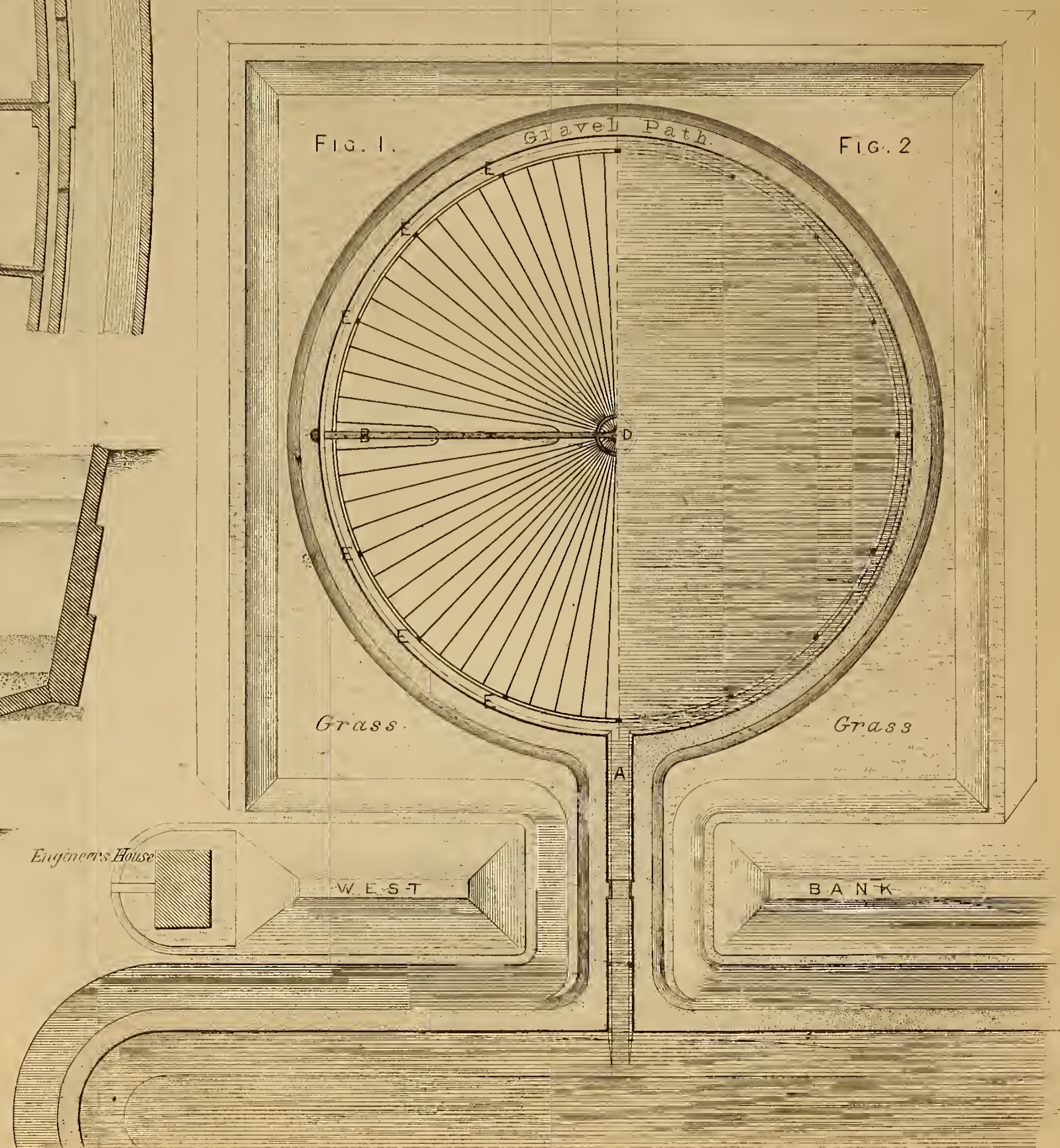


Fig. 8.

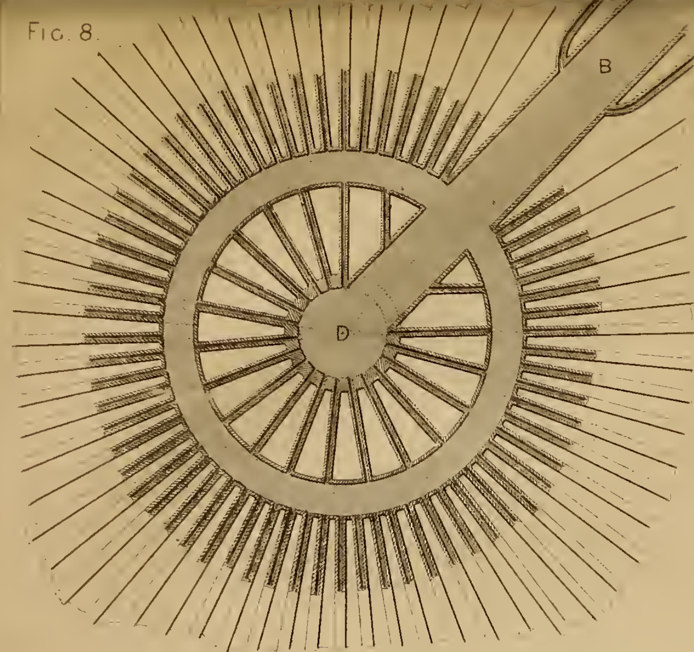


Fig. 7.

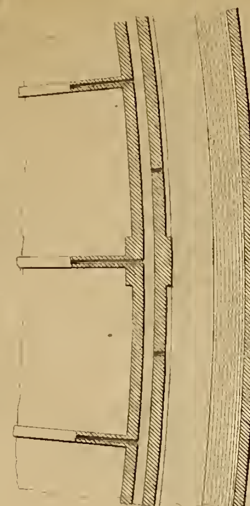


Fig. 4.

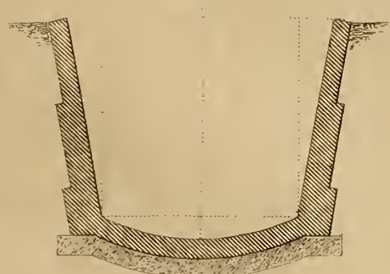


Fig. 3.

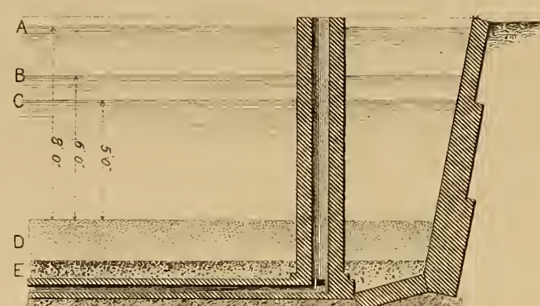


Fig. 5.

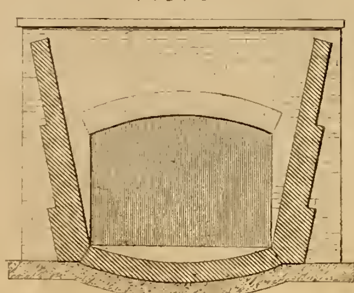
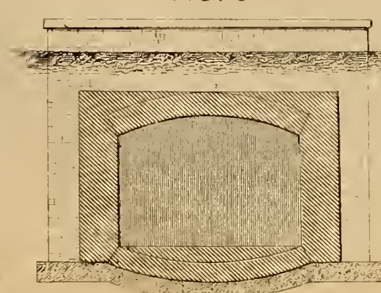


Fig. 6.



0 5 10 20 Feet

Scale to Figs. 3.4.5.6.

0 5 10 20 30 40 Feet

Scale to Figs. 7 & 8.

W. Smith. C.E. direx.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

At the meeting of the executive committee held January 30th, 1866, the engineer presented his report, of which the following is an abstract:—

"During the last month 252 engines have been examined, and 388 boilers, as well as one of the latter tested by hydraulic pressure. Of the boiler examinations, 274 have been external, 5 internal, and 109 entire. In the boilers examined, 103 defects have been discovered, 8 of those defects being dangerous.

"Another case of furnace crowns being injured by overheating has been met with, which would have been prevented by the adoption of a self-acting feed back pressure valve, and by the feed inlet being fixed above the level of the furnace crowns. Since this subject was gone into in last month's report, further reference need not now be made to it, except to point out that the present is an additional case of injury, which would have been prevented by the adoption of the above precautions; and, therefore, affords an additional argument for attention to them.

"The most important case of external corrosion took place at the bottom of a boiler set on a midfeather, and immediately where in contact with the brickwork. The extent of the injury, as is frequently the case, could not be seen until the brickwork was removed; and, therefore, it is trusted that those members whose boilers are set on midfeather walls will not omit, in preparation for flue examinations, to have the brickwork ploughed out where the transverse seams of the boiler rest upon them, so that the condition of the plates may be actually seen by our inspectors.

Explosions.

"Explosions this year are following each other in quick succession, and if they continue at the same rate, the annual list will be a long one. Already, since January 1st, six explosions have taken place, one of them of a very disastrous character, eight persons being injured, four of them fatally. The total return for the month up to January 26th is, six persons killed and seven others injured. Not one of the boilers in question was under the charge of this Association. The following is a tabular statement:—

Tabular Statement of Explosions, from January 1st, 1866, to January 26th, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
1	Jan. 1.	Locomotive	0	0	0
2	Jan. 2.	Butterley	0	1	1
3	Jan. 7.	Marine	1	1	2
4	Jan. 12.	Ordinary double-flue, or 'Lancashire.' Internally-fired	4	4	8
5	Jan. 17.	Single-flue or Cornish. Internally-fired	0	1	1
6	Jan. 18.	Portable Multitubular. Locomotive type	1	0	1
		Total..................	6	7	13

"No. 6 explosion, by which one life was lost, happened at about half-past six on January 18th, to a boiler not under the inspection of this Association, and which worked at a saw mill.

"The boiler was of a portable multitubular class, set on wheels, and its construction, generally, of the locomotive type, though it slightly differed in some respects, since instead of the fire box being at one end of the boiler, and the smoke box at the other, and the two connected with a single direct set of tubes, the fire box and smoke box in this case were both at the same end of the boiler, there being a second or return set of tubes above the others, and which passed over the crown of the fire box. The fire box had flat sides, which were strengthened with short stays, as is usual in locomotives, while the crown was slightly arched elliptically, and not stayed at all, but depended entirely on its shape to withstand the downward pressure of the steam. The length of the boiler was 8ft. 3in., and the diameter of the cylindrical barrel 5ft. 6in., while the internal case of the fire box was 2ft. 10in. long, by 2ft. 5in. wide, and the rise of the furnace crown at the centre 6in., the thickness of the crown plate, which is the only one that need be given, being a quarter of an inch. The boiler was fitted with a feed back pressure valve, a blow-out tap, a glass water tube, as well as two gauge taps, and a single safety valve, the lever of which was loaded with a spring balance, and usually weighted to 40lb on the square inch. There was, however, no steam pressure gauge, as there should have been.

"The boiler failed at the crown of the inner case of the fire box, tearing away transversely for a width of about two feet close to the angle iron, by which it was attached at the front, while it also rent longitudinally on each side of this primary rupture for a length of about 2ft. 9in., the plate still hanging on to the back of the fire box, and folding down nearly to the bottom of the ash pit.

"The cause of the explosion was investigated and reported on at the inquest by two engineers—one of them appointed by the coroner, and the other by the owner of the boiler—both of them having had experience in the construction of locomotive boilers, being engaged in the engine department of an important line of railway in the neighbourhood. Both of these witnesses concurred in attributing the explosion to simple over-pressure, in consequence of the spring balance with which the safety valve was loaded being screwed down so far as to be completely locked, so that any rising of the valve or escape of the steam was prevented. They felt confident that the furnace crown had not been overheated through deficiency of water, and also that it did not present any appearance of previous defects, but was sound, of good quality, and of uniform thickness throughout, while they considered that the boiler was perfectly safe at the pressure of 40lb. on the square inch, at which it had been ordinarily worked, and that the explosion would not have happened if the safety valve had been free in action.

"This explosion must be added to the number of those that would have been prevented by efficient boiler mountings.

"No. 13 explosion, 1865, is one of those that will constantly recur as long as steam users continue boilers in work with ill-shaped furnace tubes, and persist in the neglect of the simple precaution of having these tubes strengthened with encircling hoops, flanged seams, or by other suitable means.

"This explosion took place on March 25th, at a mine. The boiler was of the Cornish class, having a single furnace tube, and being internally fired. Its length was 28ft., and its diameter in the shell 5ft. 9in. The diameter of the furnace tube is not so easily given, since it was of the most irregular shape. At the front end it measured 4ft. vertically, by 3ft. 9in. horizontally. Midway in its length these proportions were reversed, its height being 3ft. 9in., and its width 4ft., while at the back end it measured 3ft. 8in. vertically, and 3ft. 10in. horizontally. There was not any part of the tube within at least an inch of the true circle, while there were other places more than 4in. out of shape. The thickness of the plates was about 3-8in. to 7-16in., while the pressure of the steam at the time of the explosion is reported not to have exceeded 20lb. per square inch.

"The furnace tube collapsed from end to end, but it was at the middle of its length, where its width had exceeded its height by 3in., that the collapse appeared to have commenced where the greatest amount of depression took place, the top and bottom of the tube at that part being almost crushed together.

"It appears that this boiler had nearly collapsed on a previous occasion, when it was repaired, and the furnace tube left in the distorted and thoroughly unsafe state described above. The fact of boiler makers executing their work in this way, and being entirely ignorant of the danger that must result from it, clearly shows the importance of competent periodical inspection; while this explosion is only another of those, already so numerous, that would have been prevented by the adoption of encircling hoops, flanged seams, water pockets, or water tubes, attention to which, although so frequently called in previous reports, it is felt to be a duty again earnestly to urge even at the risk of tedious repetition.

"No. 23 explosion, 1865, took place at nine o'clock on May 9th, at a farm, to a boiler not under the inspection of this Association, and which was of the plain cylindrical, egg-ended, externally-fired class. Its length was 12ft., and its diameter 5ft. 6in., while the pressure of the steam was stated to have been about 40lb. on the square inch; but there were no means of ascertaining this accurately, and it is doubtful whether the owners themselves knew the exact pressure at which the boiler was worked.

"The boiler was rent into two pieces, and divided horizontally through the centre into nearly equal parts, the one being the bottom of the shell and the other the top, the former remaining on the seating, and the latter being thrown to a distance of twenty-five yards. The engine house and boiler shed were completely demolished, the engine broken and buried in the ruins, and the thrashing machine destroyed, while one of the owners, who usually took charge of the boiler and engine, and had got up steam on the morning of the explosion, was blown to a short distance, and severely scalded, in consequence of which he died some days after. He was sensible, however, for some time after the explosion, and stated that he believed the boiler had plenty of water in it when it burst, as he had been on the top but a few minutes before, and examined the float.

"At the inquest evidence was given by two witnesses, who stated they were millwrights, engineers, and boiler smiths by trade. Both of these witnesses stated that they had examined the boiler and found some streaks of red, which, from their past experience in these matters, led them to the conclusion, although they acknowledged that the plates were thin, that the explosion had occurred from want of water. The boiler, however, was an old one. It had worked for eighteen years on the farm at which it exploded, and done service at a colliery before that. The bottom of the shell had been repaired again and again, and presented the most irregular and patchwork appearance; while on examination of the edges of the plates at which the rupture had taken place, it was found that they had been seriously eaten away by corrosion, the thickness being reduced for a considerable length to 1-16in. These facts are quite sufficient to account for the explosion, and it is therefore attributed, not to shortness of water, but to the decrepit condition into which the boiler had been allowed to fall through old age and neglect.

The Largest Wire-rope probably ever manufactured, was recently turned out from the wire factory of Messrs. Hazard & Co., Pittsburg, Pa. Two of nearly equal length and size were manufactured. The largest is nearly a mile in length, is 1⅝in. thick, and weighs upwards of 11 tons. It is to be employed on the Canal Company's plain, near Wilkesbarre, Pa

EXPANSION AND PROPULSION.

[From the Journal of the Franklin Institute.]

All persons are familiar with the transcendent achievements of steam power, and almost all consider them prelusive to others still greater; but while every one sees what it does, comparatively few perceive how it is done. Ideas of it that reach no further than external features and movements of an engine are indefinite and more or less cloudy and chaotic. Even with engineers themselves there are points on the evolution, treatment, action, and applications of the fluid far from being lucid and sharply defined. Opinions greatly vary. Two examples may here be quoted—one of marked interest to the engineering community, the other of greater importance to the national and commercial marine: 1. The economy of expansion by cut-offs; 2. The virtue of *form* in propelling blades. The competing engines of the *Algonquin* and *Winooski* will go far to settle the first, but not the second, without removing the undershot water wheels, suspended as paddles, over the sides of both vessels.

Of the economy of stopping the flow of steam into a cylinder before the piston reaches its ends, there is and has been no diversity of opinions; the fact is palpable, and such has been the uniform practice since the beginning. The points in dispute are to the extent to which the principle is urged and the amounts of gain claimed. Prevailing opinions, right or wrong, have always governed, and much that is due only to reflection and demonstration is still yielded to popular dogmas, to interest, and feeling. Inventors ofteuer build without data than with them, and, what is worse, their propositions are too commonly made bases of speculation. All this is natural, at any rate unavoidable; nor is it, on the whole, to be regretted that truth in mechanical, as in other departments of research, has to be reached through conflicts with interests and error. Without efforts to attain it we could neither be prepared to receive it nor capable of appreciating it. That which costs little or nothing is held of small account.

While admirers of "independent" cut-offs dwell complacently on that part of the operation to which "the great saving" is attributed, others glance at what they hold as a full counterbalance. Thus, when a charge cut off at one-third drives the piston through the remaining two-thirds, a clean profit is claimed. To this other observers say nay; that against it should be placed the expenditure of two-thirds more power—steam—on the first part of the stroke than was necessary, and hence that what is gained at one point is lost in another: at all events, that the difference is rather slight than serious. But may not the surplus force on the first part be recovered and applied to the latter? No, not a particle. Misspent force can no more be recalled than misspent time: it vanishes with its action and no longer exists. Yet the steam is still in the cylinder? Granted, but it no longer possesses the power gone out of it. The power is in expansion, and while the piston was stationary it was intact, but diminished as that gave way before it. At a first glance the loss may not be apparent, but the difficulty will vanish when it is remembered that communication with the boiler is not closed till the piston has passed through the cylinder to the point fixed on for the cut-off to act. Till then, the loss is made good from the boiler, and consequently does not appear in the cylinder. Could unproductive or misapplied force of any kind be recovered and turned to profit, the economy of creation would be very different from what it is.

It would, moreover, be a marvel if additional power could be got out of a definite quantity of steam by increasing its tension—if one-third of a charge at 90lbs. on the inch were more effective than a full one at 30lbs. As well expect to spin more thread out of closely than loosely packed cotton. Compression can add nothing to the fibre or fluid. The gain, however, is ascribed to economy in expending the fluid rather than to an increase of its quantity, and engineers on both sides of the Atlantic have endorsed the system. The government experiments will, it is presumed, definitely settle the question. When they are completed and published we shall learn whether the principle of high or extreme expansion is to be preferred to the doctrine of those who hold that the available force of the charge can vary but little, whether compressed into one-tenth, one-quarter, or one-half of its initial volume—that disbursing steam and money is much the same, a gold dollar going no further than a silver one, nor it varying in value, whether laid down in one piece, or in halves, quarters, or dimes. There are probably no expenditures of force unattended with loss or waste, but by no system of saving can the principle be reversed, and the outlay of one portion command a return due to a greater.

It is to the second proposition this paper is intended more especially to invite attention—one of high import to the government, since it involves the question of speed, and that in vessels of war is vital, is everything. It has elsewhere been remarked that an increase of a few knots in our cruisers would have virtually ended the late horrible war two or three years ago, saved thousands of lives, and multiplied millions of money—that it may as well be obtained as current rates, and will be, though perhaps not without further struggling against a plain law of physics—plain and perfect to those who look into it, a stumbling block and foolishness to those who do not: that is, those who prefer rectangular planks to the form of blade which science proclaims and nature everywhere confirms—whose ideas of driving ships over seas and rivers are those of the builders of Roman galleys and engineers of the Middle Ages. They propelled vessels by two, four, and sometimes six oxen. Two were yoked to and travelled round a vertical shaft, and each shaft carried a pair of paddle wheels identical with those by which they ground corn on the edge of running streams, and in boats anchored on rapid rivers.

If there are other examples of non-advancement over the dark ages as gross as this we know not where to look for them. Our planet is a school for engineers as for other professions. It is alive with mechanical laws, as fixed and immutable as the universe itself; and nothing is more certain, that only so far as our devices accord with them can they succeed. Thus it will be, as heretofore, with the propelling blades of a steamer as with the force that propels them. Abortive must be all attempts to make her speed what it ought to be as long as the principle of form, so distinctly and variedly manifested in organisms that move rapidly through air and water, is ignored. It is fundamental. No finite intelligencss can improve or supersede it. There is marvellously more in it than common observation perceives. It governs other attributes. Endless are the projects on minor points, and all of them fruitless for lack of that which only can give value to any.

Every horizontal section of a blade has a different velocity, and, to make the resistance and effect uniform, its width must diminish with the dip. The centre of resistance, instead of being near the extremity, will then be drawn in towards the centre of the blade, and economy of force will result. There is, in fact, a reciprocal influence pervading every part, every feature and movement of a perfect blade; and wherever this harmonious action docs not exist, loss of speed and waste of power are and will for ever be inevitable, for physical laws are eternal. There are some things which the present state of science and the arts cannot accomplish; but there is no obstruction, mental or physical, to our giving to sea boats a maximum of speed with a minimum of force—to our rivalling in this respect the ablest engineers of the future.

If not disgraceful, it certainly is not creditable to American and European engineers that the problem has not been solved before now. It would seem impossible for it to be much longer neglected. The present opportunity of again bringing it to the notice of the Navy Department is singularly favourable. Numerous public vessels have been sold, and more are yet to be disposed of. Out of so many, one or two might surely, and without injury to the public interest, be detailed for the purposes of experiment. The British Government has experimental steamers, and much more should ours; but passing that, all that is now asked is that the *Algonquin* or *Winooski*—the one which proves the fleetest in the approaching trial—be fitted with blades on the principle recommended in the Patent Office Report for 1849. It is therein demonstrated that speed is essentially affected by the figure, thickness, and number of the blades—that their propelling power expands and contracts with the volumes of water they displace. Ocean steamers had them of 2½in. 3½in. and even 4in. thick, amounting to from 400 to 500 cubic feet of solid timber to be kept whirling through air and water, and losing on the average 7ft. of effective stroke (the aggregate thickness of one wheel's blades) at each revolution; some wheels actually lost 12ft. of stroke at every turn. But there were engineers then who maintained the hypothesis "the thicker and heavier the blades the better, for the heavier the wheels the easier they work!"

The length of paddle planks then varied from 12ft. and 14ft. to 22ft. The incessant jar arising from their striking the water was shown to be a ceaseless source of destruction to both engine and vessel, as well as waste of power. Some boats had wheel houses wider than their decks, so as to make it doubtful to strangers of such craft whether the hulls were accessories to them or they to the hulls. In this respect the number of blades has been greatly reduced. There where then steamers with 36. The *United States*, among others, had one bolted to each side of her radial arms or levers. The number settled down to 28, next to 14, and now there are examples of only 7 being employed as urged in the Report. But the most important suggestion is yet ignored by those who have taken advantage of the rest, and, with scarcely an exception, without the slightest acknowledgment. It will, however, yet be conceded that the naked arms of old steamers' wheels would, if sufficiently lengthened, have propelled them more effectually than the usual plank paddles attached, because of their approximating the only principle applicable to the case—that which nature illustrates in the long, narrow, and tapered organs of her swiftest swimmers and flyers, and, (as there is no originating a law or principle of our own) which, in order to succeed, we must adopt, or fruitlessly oppose and fail as heretofore. Instead of churning the water's surface with wide dashers, we must take deep hold of it with blades that enter without jarring and lift no loads of if on leaving.

The usual prenomen to steamers' wheels is a wrong one, there being no analogy in their action and that of the Indian's paddle. To resemble it the longer axis of the floats or buckets, instead of being parallel with the shaft, should be perpendicular to it, and instead of seeking resistance away from the hull, find it in depth close to it. The oar reaches out, but that is to adapt it to human power. Sweeping horizontally through the water at a much greater distance, more power is lost in being imparted to its blade than to that of the paddle. In large wheels the loss is considerable, as the power has to pass to and from the furthest ends of the buckets, whose action is really that of rotating oars—widely different from that of vertical paddles which would dispense with three-fourths of the massive overhanging shafts. To use the narrow blades of paddles for undershot wheels would be quite as rational as employing the wide planks of the latter for propellers.

A series of experiments was proposed to the administration of President Taylor, and a vessel (the *Water Witch*) was designated for the purpose, but his sudden and lamented death put an end to the design. Conducted under the supervision of the heads of the Coast Survey and Smithsonian Institution, scientific officers of the navy and representations of the Franklin Institute, the result, whether in favour of or against the current wheel, would have been of lasting value, and so will the solution of the problem be whenever and by whomsoever it is accomplished. The government has now another reliable source of information and advice in the National Academy of Science.

In 1855, Professors Bache and Henry, in a letter to the Secretary of the Navy, stated that the proposed experiments "would be of great practical value to the world at large, and of particular advantage to the navy of the United States." But the time for them had not come. The reply was, "The Department appreciates very highly the importance of a series of experiments on the best form of propelling blade or paddle for producing, with a given expense of power, the greatest useful effect. It has, however, to regret the want of authority to under, take them, ... and could not, without inconvenience to the public service-furnish a vessel for the purpose."

It may be that the Navy Department inclines to the opinion of some of its subordinates, that the paddle wheel is all that is wanted, and, so far from ever being superseded, is destined to move the earth's fleets of steamers as long as its

prototype trausmits power from runniug streams to mills and factories. Well, why not then have a practical demonstration of its superiority, which would repay the cost a thousand fold, and reflect enduring honour on the Department. The expense can hardly exceed the tithe of a tithe of the pending experiments on steamers aud steam. Were it as great, it would be true economy to incur it.

There is, of course, an end of the question of propulsion with those who think there is no natural law or principle of velocity in steam vessels, or, if there is, that it has no relation to the form of propelling instruments. If they are right, the highest speed has been attained, and we may sit down and rest satisfied with the common wheel, for there is no risk in repeating the assertion that uothing more is to be got out of it. After undergoing endless variations in details, its dimensions have been swelled to extreme practical limits, aud to meet the resistauce an unprecedented amount of metal has been put iuto the shafts—and to what purpose? The largest have been strained to breaking, yet no increase of speed. But it is preaching in the desert to reason with those whose ideas of progress are bounded by the present—who imagine steam fleets of the future arc not to surpass those of to-day.

The sole motive in calling the attentiou of the United States Government once more to the subject is an abiding conviction of its importance to the navy. The writer has no selfish object to accomplish—no wish to divert a dollar from the Treasury into his pocket. He has nothiug to gain by the adoption of his views, and nothing to lose by their rejection.

ON THE CONDENSATION OF STEAM IN THE CYLINDER DUE TO EXPANSION.

By FRED. J. SLADE.

Much has beeu written of late to prove that the long received opinion that a great economy is derived from workiug steam expansively, is quite fallacious; and, notwithstanding the vast amount of practical evidence in favour of the old belief from the well known results of most extensive practice, both in this country and abroad, many have had their faith shaken in the value of more than a very limited amouut of expansion, partly by a few experiments perhaps not altogether free from sources of error, and to a greater extent, no doubt, by arguments put forth by persons who should have had great experience, and whose views therefore carried with them considerable *primâ facie* weight. In this train of argument the main assumption has been that there is, as a necessary consequeuce of the act of expansion, a great condensation of steam in the cylinder, aud this has been dwelt on in some instances till the most alarming effects would appear to result from it. Starting with a most singular fallacy as to the relative amounts of heat in steam of high and low pressure,* Mr. Isherwood has pictured to us how this coudensation multiplies itself beyond measure. Unfortunately, those who have written upon this subject have discussed it entirely in general terms, instead of bringing it directly to the test of numerical calculation, as it is possible to do, and thereby ascertaining exactly what the amount of condensation is, and what loss of power results therefrom.

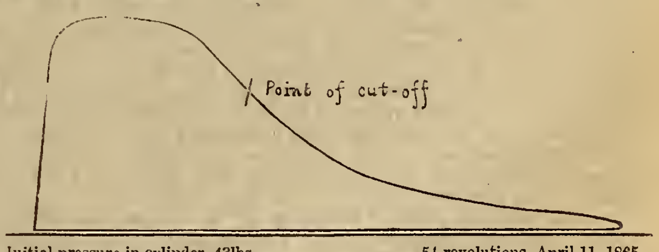
The total heat of steam increases slightly with the pressure. If then steam could be expanded without being allowed to do any external work, as, for instance, by allowing it to expand into a vacuum, the steam after expansion would contain slightly more heat than was due to its pressure, or, in other words, would be slightly superheated. This fact has been beautifully illustrated experimentally by Professor Tyndall, nsing a vessel of compressed air, which, being allowed to expand into a vacnum, it was shown that the amount of heat absorbed in starting the particles of air into motion was exactly balanced by that given out in bringing them to rest again; and no other work being done, no heat was absorbed. This gain of heat in the case of steam is from 20 to 25 per cent. (according to the pressure) of the amount absorbed whcu the expansion takes place against resistance. In the steam engine, however, the case is different; for here the steam does work in expanding aud absorbs an equivalent amount of heat, which has to be supplied by the condensation of a portion of the steam. The exact amount of heat required is readily found from an indicator diagram—every 772lbs. of pressnre through 1ft. of stroke requiring an absorption of an amount of heat competent to raise the temperature of 1lb. of water 1° F. Now, it has been assumed that the expansion of the steam to fill the vacancy caused by the condensation uecessary to supply this amount of heat, was the cause of a further absorption of heat and consequent condensation. That this is fallacious is evident when we reflect that the heat equivalent to the work done in moving the particles of steam is exactly replaced by the act of bringing them to rest again; just as a body moving in a vacuum gives out as much force in being stopped as it originally required to set in motion. Moreover, as the condensation of steam due to the work done reduces slightly the pressure, there is a slight excess of heat which goes to lessen, to a small extent, the condensation.

The force required to remove the particles after the piston, involves a disappearance of heat during the continuance of the stroke, and a consequent diminution of pressure. This heat, though given out again when the particles are brought to rest at the end of the stroke, is lost as far as direct power is concerned, but goes towards heating the piston and cylinder. The absolute amount of heat required in thus moving the particles of steam, is, of course, small, and yet as this loss has been urged as one of the objectious to expansion, let us give it its exact value, which is found as follows: When the steam is cut off at half stroke the work done in the act of expansion itself is the moving of all the steam in the cyliuder through a distance equal to one-quarter the stroke, in the time of half the stroke. If cut of at one-third stroke it is the moving of all the steam a distauce of one-third the stroke, in the time of two-thirds the stroke. If cut off at one-quarter stroke, the steam is moved three-eights the stroke in the time of three-quarters of oue stroke, aud so on for other degrees of expansion, each of which would be equal to the whole mass of steam moved a distance of half the stroke in the time of one stroke, were the spaces moved through exactly proportional to the times. The difference due to this inequality being insignificant and the total amount of work extremely small, we may assume this value as abuudantly accurate. Now, suppose the mass of steam to be 1lb. and the speed of piston 1,000ft. per minute, then the work done will be imparting to this mass a velocity of 500ft. per minute, or 8.3ft. per second, which is about equal to the effect of the force of gravity acting on the same mass through 1ft.; the work done, therefore, is equal to 1lb. raised 1ft. high—a totally insignificaut amount iu comparison with the whole work done by the engine during the same time, which iu the case supposed might easily be 90,000lbs. raised 1ft. "The condensation duc to expansion, *per se*," therefore does not amount to much.

When the exhaust valve opeus, the particles of steam rush with great velocity into the condenser, and the acquisition of this velocity involves an absorption of heat. Suppose the pressure in the condenser to be 1lb. per square inch, and that in the cylinder at the commencement of the exhaust 15lb. Then the work done by 1lb. of steam in expanding through this difference of pressure will be 109,829ft. lbs. = 142 units of heat. Of this 37,872ft. lbs. are employed in overcoming the head resistence in the condenser of 1lb. per square inch offered to the expansion of the steam. The remaining 71,957ft. lbs., were the steam unimpeded in its flow, would impart to it a velocity of 2,145ft. per second. Owing to friction, &c., the actual velocity will always be less than this, aud the difference betweeu the number of ft. lbs. adequate to produce the actual velocity and that already given (71,957) is the measure of a portion of the work or heat that is returned to the steam and to the sides of the cylinder aud pipes in the destruction of motiou by friction.

Supposing the pressure at the end of the stroke to be equal to that of the atmosphere, the steam will have a total heat of 1178·6°, and if the temperature of the condenser be 104° F., corresponding to a total heat of steam of 1146·2°, the surplus of heat in the steam remaining in the cylinder during the exhaust stroke would be 32·4°, did it require no heat to set the particles in motion; but the quantity of heat required for this purpose being, as we have found, about 140°, the steam instead of being superheated is partially condeused, and deposits moisture on the cylinder.

Now, let us take au actual example, and apply the foregoing method of calculation to determine precisely what loss results from the varions operatious goue through during the stroke. The accompany diagram is one of a number taken from a stationary eugine, 10″ diameter of cylinder, × 20″ stroke, cutting off at about one-third stroke, by a slide on top of the main valve. The average pressure measured on the diagram is 34·5lbs. The area of a 10″ piston = 78·5in. which, multiplied by 34·5, gives 2708·5lbs. raised 20in. as the work done by the steam used in oue stroke equal to 4,514lbs. raised 1ft. This amount of work is equivalent to $5\frac{5}{8}$ units of heat.



Initial pressure in cylinder, 43lbs.
Boiler pressure, 60lbs.
54 revolutions, April 11, 1865.
1″=23lbs.

The pressure in the boiler was 60lbs. above the atmosphere, and the initial pressure in the cylinder 43lbs. Assuming the gain of heat due to this expansion to have been neutralised by radiation from the steam pipe and chest, we have next to consider the gain of heat from a reduction of pressure from 43lbs. to 4lbs. above the atmosphere, which is 1202·5°—1182·7°=) 19·8°. The capacity of the cylinder is ·9086 cubic foot, and the weight of a cubic foot of steam at the pressure of 4lbs. is ·044lb. The contents of the cylinder, therefore, weighs ·04lb., and the increase of 19·8° in this quantity of steam is equal to ·8 of a unit of heat, which, deducted from the $5\frac{5}{8}$ units of heat required to do the work, leaves still about 5 units to be supplied by the condensation of the steam. The latent heat of steam of 34·5lbs. pressure is 934°, and therefore to obtain 5 units of heat, it will be necessary to condense .0055lb. of steam, or about $\frac{1}{8}$ of the total quantity contained in the cyliuder. The gain of heat duc to the reduction of pressure arising from this condensation will act to diminish the condensation by about $\frac{1}{60}$ of itself—a quantity too small to be considered in view of the inherent uncertainties of the case, making it impossible to tell from a diagram *exactly* how much steam has been admitted to the cylinder. The pressure at the end of the stroke is 4lbs. above the atmosphere, or 19lbs. total pressure. After the opening of the exhaust valve, it falls to 16lbs. equal to an enlargement of its

* Mr. Isherwood states (p. 56 "Engineering Precedents, vol. ii.)—"Although the total heat of steam of higher pressure is greater than the total heat of steam of lower pressure, yet, as the latent heat of the latter increases in a much higher ratio than its total heat diminishes, and as this increase in the latent heat is at the expense of the sensible heat, it (expansion) becomes a cooling process, and produces the condensation stated." That is, after admitting that the total heat which includes and is the sum of the latent and sensible heat is greater in high than in low pressure steam, he claims that this greater total heat will not be sufficient for the less. He must forget that in lowering the pressure the sensible heat diminishes faster than the latent heat increases, and therefore it is that the total heat is less in the lower pressure steam. The diminution in the sensible heat yields up, so to speak, more heat than the increase of latent heat demands; hence steam expanded from a higher pressure without doing any work is slightly superheated.

volume from ·9086 cubic foot, to 1·08 cubic feet. The work done in this expansion is 406ft. lbs. To raise a column of atmospheric air of an area of 144 square inches, ·171ft., or, in other words, to overcome a resistance of 2,160lbs. through that distance = 369ft. lbs. of *external work*. The remaining 37ft. lbs., minus that absorbed in friction, is the *internal work* of imparting to ·171 cubic foot of steam of 16lbs. pressure the velocity with which it was ejected by expansion from the cylinder. This velocity we may take as about 400ft. per second, to acquire which a body would have to fall through 2,496ft. The weight of ·171 cubic foot of steam of steam of 16lbs. pressure being ·0065lbs., the work done is equal to 16·5ft. lbs. The sum, therefore, of external and internal work done in exhausting is 385·5ft. lbs., equal to one-half a unit of heat, to supply which will require the condensation of ·00052lb. of steam.

We have thus considered the action of the steam through every portion of the stroke, and have found by definite calculation the loss or gain of heat in each operation. We have seen that the principal and only considerable loss of heat is that necessarily abstracted in the act of performing the work—this, of course, is constant for the same amount of work, whether we use the steam expansively or follow full stroke. The work required to drive the particles of steam after the piston in expanding has been shown to be absolutely insignificant, but even if it were of any account, it would operate against the full stroke engine, as in this case a larger mass of steam has to be set in motion. On the other hand, we find that there is a slight gain of heat due to expansion, *per se*, equal in the case we examined to one-seventh the amount required to do the whole work. If this investigation may do anything towards freeing this subject from vague speculations, and substituting sounder modes of reasoning, it will not have been undertaken in vain.

Experience, if it be intelligently comprehended, is the safest guide in all such matters; but it helps us in interpreting experience, and suggests new directions for experiment to apply the known laws of physic to obtain a theoretical solution of the problem.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The thirteenth anniversary dinner of this association took place on Saturday evening last, at the Freemason's Tavern. Mr. J. R. Ravenhill, C.E. presided. The company numbered about 250 gentlmen. Amongst them were Mr. James Stabler (deputy-chairman), Captain Clark, R.E., Commander J. W. Reed, R.N., Robt. Mallett, Esq., C.E., Mr. J. Samuda, M.P., Mr. J. Newton (chief engineer to the Mint and president of the London Association of Foremen Engineers), Messrs. E. Humphrys, E. J. Reed (chief constructor of the navy), J. Robertson, William Blackett, T. Sanson (vice-president of the association), M. Jones, J. Irvine, W. Keyte, J. Penn, junr., S. Bagshaw, and Lieut. D. Campbell (Sheffield).

From a report which was read by the secretary (Mr. D. Walker), it appeared that the various departments of the association had continued to progress during the past year. The number of members had greatly increased, many of them holding positions of considerable importance in the trade. Twenty-two hon. members had been enrolled, and twenty-three ordinary members; two ordinary members had withdrawn, and three had been removed by death. An effective list of eighty-seven ordinary members remained, and fifty hon. members, making a total of 137. The funds had steadily increased, although this year the claims upon them had been unusually heavy. The receipts for the year amounted to £215 10s.; expenditure £183 4s. 0½d.; leaving a balance of £32 6s. 8½d., which, added to last year's stock (£396 10s. 5d.), made the present fund £428 17s. 1d. Various new and standard works and scientific periodicals had been added to the library, and the books had been re-arranged and a catalogue prepared. The superannuation fund is now an accomplished fact, the sum proposed by Mr. Grissell as a nucleus having been realised, and £541 15s. invested in the purchase of £600 worth of stock in the Three per Cents.

The Chairman, in giving "Prosperity to the London Association of Foremen Engineers," remarked that it was now some fourteen years since sixteen members of the trade put down 5s. each as an earnest of their sincerity in forming the association. Since then, as they were aware, the institution had gradually progressed, and now it was in a position which he thought called for general congratulation. He had watched the association with some interest. From what he knew of it he thought if it continued to be conducted as it had been it was deserving of the support of all the large employers of the metropolis.

Mr. J. Newton, president of the association, responded. In the course of his remarks he dwelt particularly on the fact that this association had nothing whatever to do with trade disputes, such questions never being allowed to be introduced into its meetings; that its great objects were to create and foster a good feeling among employers and employed; to make the employed more intelligent and better workers, and therefore of more service to their employers, and to provide against the consequences of sickness and death. He felt confident that all who would inquire into the matter would admit that it was really as much the interest of the employer as those in his service that such an association should exist.

Considerable contributions were subsequently made to the superannuation funds, and at twelve o'clock the festival closed.

THE NATIONAL BOILER INSURANCE COMPANY (LIMITED).

[From the Report of Mr. Henry Hillier, Chief Engineer, we extract the following particulars.]

During the past year no explosion has occurred to any boiler insured with this company. Some of the boilers have been injured through mistake or negligence of the attendants, and other cases have been reported where serious injury would have been sustained, had the boilers been unprovided with good fusible plugs on the furnace crowns, which, by their timely action, prevented damage.

One case of partial collapse of the furnace tube of an insured boiler is worthy of special note. The boiler was fed with water strongly impregnated with salt and chalky matter, which, owing to omission of frequent cleaning, was so thickly deposited on the furnace crown as to cause overheating of the plates, and consequent injury. The use of good surface blow-out apparatus would have prevented the accumulation of the deposit and subsequent damage to the boiler.

Defects.

Many serious defects, some of them of most dangerous character, have been met with in the boilers inspected. Some of these are referred to below, the notes on others are included in the remarks on fittings, &c.

Many furnace tubes were found which had been more or less distorted through previous deficiency of water. Some of the defective tubes were strengthened by staying the weakened part, others had been partially restored to original form, but still bore evidence of the distortion and strain to which they had been subjected.

Cases of leakage at joints of fittings, and at manhole joints are so numerous, and the consequent corrosion of the boiler plates frequently so serious, that special remark thereon is requisite. Leakage is often allowed to go on unnoticed until the adjacent plate is so much reduced by corrosion, that extensive repair becomes necessary. This is especially the case where the leakage runs down into the brickwork setting of the boiler, as the progress of the corrosion is thereby hidden, and frequently not suspected until the weakened plate gives way, in some instances leading to disastrous explosion. Boilers not protected by shed or roof are liable to similar damage from external moisture, besides the great loss of heat which continually occurs.

Internal corrosion is frequently met with, in some cases seriously weakening the boiler in a very short period. As an instance, I may mention that the plates of an externally fired boiler (not insured) which exploded, were stated to be reduced from the original thickness ⅜in., to 1-16th. in., although the boiler had worked but little over eighteen months. In most cases its progress may be arrested by the daily admixture of a small quantity of common soda with the feed-water. In any case where the use of soda does not prove effectual, I would suggest that the water should be analysed by a first-class chemist, who would doubtless be able to recommend an antidote.

Serious grooving is occasionally met with near the seams, especially at the ring seams of externally fired boilers. As this grooving is frequently hidden by the incrustation and may thus pass undetected, I would impress upon boiler owners the necessity of the removal, as far as possible, of the scale and sediment inside the boilers, when preparing them for thorough inspection.

Many of the leading boiler makers now rivet on the boilers suitable joint-beds for the fittings, and good mouthpieces with planed joint faces at the manholes, which must facilitate the proper making of the joints and materially strengthen the boiler. Where these beds are properly attached and the joints thereto carefully made, leakage is avoided, and much trouble and expense saved to the owners. The advantage of providing the rivetted beds does not appear to be generally appreciated, as I find that many boilers are still being made with the fittings merely bolted on. One explosion is reported during the past year, by which two men lost their lives, and which is stated to have been caused by the failure of the manhole cover.

The liability to fracture at the rivet holes of the furnace seams of externally fired boilers is well known, and many of the boilers proposed for insurance were more or less defective from this cause. One case was reported where nearly a score of the rivet holes in one ring seam, were fractured to the edge of the plate.

Internally fired boilers frequently fracture at the ring seams of the lower part of the shell, through unequal expansion, due to sufficient circulation of the water. One of the boilers insured with this company recently failed at the lower part from the cause stated, but the fracture did not extend along the line of rivets, as is usually the case, but occurred near the seam, the plate thereat being somewhat thinned by corrosion, owing to previous leakage at the seam. The defect was discovered through the leakage which resulted.

(*To be continued.*)

Obituary.

DEATH OF MR. DAVID ELDER.

On the 31st of January, at his house, 19, Paterson Street, Glasgow, died Mr. David Elder, in tbe 81st year of his age.

To tbose who are conversant witb the progress of mechanical engineering in these kingdoms during the present century, the name and fame of Mr. Elder are as familiar as housebold words. Associated with Mr. Robert Napier, as his foreman and manager, since 1822, at which time Mr. Napier had never made an engine, it was he wbo reared up into celebrity and greatness the engineering firm of Robert Napier and Sons, and the whole Clyde—every engineer and ship-builder in it,—has participated in tbe benefit and reputation which Messrs. Napiers' successes bave conferred. To Mr. David Napier—the cousin of Mr. Robert Napier, and his predecessor in Camlachie foundry, the Clyde no doubt owes its first celebrity in the art of steam navigation. But Mr. David Napier, with a remarkable amount of mechanical genius, was too impatient and fitful in his operations, and too negligent of the quality of his workmanship, to build up a solid commercial manufacture, and his reputatiou for producing satisfactory work was on tbe wane before Mr. Robert Napier entered the field. From all such faults and objections Mr. Elder, from the first, took care that Mr. Robert Napier's work should be free. For strength, solidity, efficiency, and endurance, his engines were from the first, unrivalled, either in Scotland or anywhere else, and whatever excellencies they possessed it was confessedly to Mr. Elder that they were to be wholly imputed. The consequeuce of the manifestation of these qualities was, that work flowed in upon Mr. Robert Napier, and bis reputation was gradually built up to the dimensions wbich it now possesses. Throughout the whole of this operation Mr. Elder was the real moving spirit, and was well known to be so by engineers and others, by whom the realities of the case were discerned.

The following orbituary notice of Mr. Elder we extract from the *Scotsman.* The facts it recounts we know to be substantially correct, and the notice is manifestly tbe work of a skilful and appreciative haud:—

Mr. Elder was born at Little Saggie, near Kinross, on the 18th of January, 1785. His father and grandfather were country joiners, wheelwrights, and house builders. His grandfather, who was living in 1745, appears from mauuscripts still extant to have been a man of unusual ability, and possessed of accomplishments which must have been extremely rare amongst working-meu 120 years ago. His neatly written notebooks are full of calculations displaying an acquaintance with algebra and theoretical mechanics which entitles him to be classed as a scientific mau.

The subject of our notice sneceeded in 1808 to the small business formed by his ancestors, and, inheritiug also their talents, he speedily sought a wider field for the exercise of his abilities. In 1812 he married, and moved to Paisley, where he was engaged for three years as chief millwright and architect for the extensive thread-making establishment now John Clark, junr., and Co. His reputation as an able designer and constructor of architectural, engineering, and mechanical works, increased rapidly; and in 1817 he removed to Glasgow, where he was extensively eugaged in designing and superintending the construction of some of the largest cotton factories in the west of Scotland. Amongst other works which he designed and carried ont about this period were Messrs. Dunlop's mills at Broomsward; Messrs. Gillespie's mills at Woodside; Chemical Works for Messrs. Tennant; Hurlet Alum Company's Works; Thread Factory for Messrs. John Clark and Co., &c.

In 1822 Mr. Elder formed a business connection which has had the effect of keeping his name from becoming as widely known in the world as it deserves to be. He had been in the habit of getting his castings made by Robert Napier, who had started a foundry at Camlachie, at the east end of Glasgow, and he accepted an offer made by Mr. Napier to become his manager. This connection existed for nearly half-a-century; and during that long period the world has vastly changed, and changed in no small degree for the better, through the exertions of these two men—Robert Napier and David Elder. The small foundry at Camlachie soon became too small for a rapidly extending business.

The engines of the *Leven,* a steamer intended for the trade between Glasgow and Dumbarton, were soon after this designed by Mr. Elder; and in succession the engiues and boilers of the *New Dumbarton, Sultan, Greenock, Helensburgh, Clarence, Ardincaple, Eclipse,* &c., were turned out of the rapidly exteuding workshops of Mr. Napier.

The admirable designs and the accuracy of the workmanship which Mr. Elder introduced into marine engineering soon raised the character of the establishment of which he was manager. Orders came flowing in from all quarters; and lines of steamers running between Glasgow, Belfast, Londonderry, aud Liverpool; and also between Liverpool, Londonderry, Isle of Man, Drogheda and Sligo; Aberdeen and London; and Dundee and London—were in succession provided with steam machinery designed by him.

The reputation acquired by the great works which had grown out of the small foundry at Camlachie had, in 1839, become so pre-eminent, that Mr. Cunard naturally looked to Mr. Robert Napier to supply him with ships for his projected line of steamers to cross the Atlantic.

In 1838 Mr. Elder designed the engines of the *British Queen,* of 2,000 tons burden, and 500 horse-power, and fitted with improved Hall's condensers. This vessel was followed by a long succession of magnificent ocean steamers, every one surpassing its predecessor in size, speed, and splendour. culminating in the Persia, the last of the series, and as yet unequalled by any ocean steamer afloat. In constructing the big engines of the past generation, the tools and machines which render the work easy enough now had not then been devised, but had to be designed and constructed as the work advanced. Mr. Elder's ready resources and great capacity for grappling with and overcoming difficulties showed that he possessed true mechanical genius. Whether his difficulties arose from the natnre of the work or the obstinacy of workmeu—who in those early days were as much given to strikes as they are now—he was always ready to face and work through all obstacles. He had the skill to pick out, and the power to impart to, able workmen of any kind something of his own capacity. Not a few men who have risen to eminence in their profession, and become owners of great establishments in Glasgow, commenced their career under Mr. Elder. He never knew what it was to be beaten, and he had the valuable faculty of communicating this great element of success to all who worked under him.

His connection with Mr. Robert Napier was based, for abont a quarter of a century, on a fixed payment per horse-power; bnt it is well known that to be successful as a marine engineer was more the object of his ambition than any personal gain. This object has been achieved most completely. Robert Napier was, ann fortunately still is, a great uame in marine engineering; and David Elder will long be remembered as the father of marine engineering in the Clyde. The vast importance of this industry will be seen when it is mentioned that there are more marine engines produced on the Clyde than in any other port iu the world. It is difficult to believe that the workman who actually put together the engine of the *Comet*—the first steamboat that plied regularly for hire on the Clyde, or in Europe—is still living in Glasgow. So it is, however. Mr. Robertson is still living; and the qneer-looking engine of the *Comet,* which he erected for Henry Bell in 1811, is now in the Museum of Patents at Keusington.

The anecdotes told by Mr. Elder of the early days of mariue engineering were full of interest. He had seen its origin, and lived long enongh to see one of his sons, whom he had traiued himself, the head of one of the greatest marine engineering and iron ship-building establishments in Europe.

Mr. Elder's personal character was remarkably definite. He was very "hard-headed," yet humourous and genial. He formed excessively fixed opinions on all mechanical and engineering questions, considering, as he did, that theory and experience together ought to leave no room for doubt. On theological questions, on the contrary, he, although religious in himself, after a peculiar and unfashionable fashion, was extremely tolerant to those with whom he differed. He took a keen interest in questions relating to the Church, and was remarkably well informed on all points of church history. In architecture and music, his taste was cultivated to great refiuement. Several organs were built by him in his leisure hours. Whatever he gave his mind to he displayed in it faculties of the highest and most varied kind.

Mr. Elder has left a widow and three sons. His sons are all engineers. They may well be proud of the work their father has done in the world. He had a great task to do, and he did it well.

REVIEWS AND NOTICES OF NEW BOOKS.

The History of Sugar, and Sugar-yielding Plants. Longman, Green, and Co.

This is a very readable book, and contains much valuable information. Its style is easy. The facts, we are told, are collected from the bighest sources of information, and the author has put his gatherings into a clear and useful form. His preface is verified in the "analysis and condensation of facts. * * * The accuracy of the statistics may be depended upon from the fact of their being principally derived from Parliamentary papers, which latter reveal an increased consumption of sugar in tbis country at the present time, that comparatively few of the public would have imagined. Tbus, wbilst in 1700 the quantity of sugar consumed in the United Kingdom was 10,000 tons, in 1864 the quantity bad increased to 486,833 tons." These patent facts demonstrate tbe growing importance of the subject treated on. It has acquired a new importance, from the fact that beet-root sugar is competing in our markets with cane sugar; thus reducing the price of sugar, and the profits of the planter. From "the beet root circular" of Messrs. Arnold, Baruchson, and Co., of Douai and Liverpool, we learn that 70,000 tons of beet root sugar has been purchased for Great Britain. Either cane sugar mnst decline in price, or an advance must take place in beet. The disproportion in value has already led many refiners in Great Britain, who hitherto have resisted its introduction into tbeir houses, to purchase beet, and it is predicted, that those refiners who still object to it will have to adopt its use, or find themselves unable to compete. The constant improvements in the process of manufacture are also in favour of the produce of beet. The quality of the present crop in France and Belgium, and also in Germany, continues to be very satisfactory. The probable total production for the year, from the more perfect information now possessed, is computed at 560,000 tons." The luxurious planter might have been content with his products, so long as his price for sugar maintained that luxury. Now, he is inquiring for better methods. The Cubanos subscribed a purse of 35,000 dollars the other day, and placed it at the disposal of a local chemist to cover his expenses for experiments. That there is room for improvement, is clear in the pages before us. "If," says our author, and correctly too, "If a length of sugar cane be cut into thin slices, so thin as to be semi-transparent, admitting of microscopic examination, then, on drying one of these slices at a moderate temperature, and examining it microscopically, minute crystals of *white* sugar may be observed." We may pause to remark that this natural sugar is not contaminated with lime or treacle. These contaminations are due to the undesirable crude process of manufacture. But, to resume. "Now, a question very natural to arise is this: Inasmuch as sugar, actually white, can be demonstrated to exist in the cane, how comes it that sugar, yellow, or brown (and treacle), is sent to us from the colonies? The reply to that question is most easy, and most lamentable. * * * It (the present process) destroys a certain portion of the original sugar. If a portion of moderately rich sugar cane were handed over to the chemist for laboratory experiment, the cbemist would rarely extract less than 17 per cent. of pure white sugar. Supposing the cane to be very rich, theu the quantity of pure white sugar extracted might amonnt to no less tban 23 per cent." Now comes tbe astounding fact: "In commercial practice, rarely is more tban 7 per cent. extracted, and that not in the condition of pure white sugar, but of a yellow or yellowish brown product, commercially known as muscavado." We have known the common process to produce 9 or 10 per cent. with proper

attention, and we believe 12½ per cent. has been got with extra labour and questionable profit. Thus, in general terms, the cane juice which contains two hogsheads of sugar, is so improperly treated in the common process of manufacture, that it yields but one hogshead of sugar for the planter to sell. Our author adds, very significantly, "It would he in vain to scan the records of chemical manufactures to discover a sacrifice so great."

We next have a general idea of the sugar mill. The main object of onr engineers appears to have been, to make the mill strong enough to express all the contained juice of the cane, and that with success. Still its applicability is incomplete, yet might be made complete, and the requirements are not met, becanse the engineers were not chemists also. The author goes on :—"If the composition of the sugar-cane juice were merely a solution of sugar in water, the subsequent stages of manufacture would be most easy; but unfortunately it is a very complex product * * * A considerable portion of the impurities associated with sugar, in sugar cane juice, may be separated by heat alone, not the whole, however. To effect a total separation, or, more properly speaking, such an amount of separation as will permit the crystallisation of sugar, it is absolutely necessary that some chemical agent be applied. Lime is commonly used for this purpose, and the utmost possible care is required that an unnecessary excess of it be not used. Employed for this purpose the lime is called 'temper,' and the operation of using it, tempering." The autbor is correct in noticing the necessity for lime to induce crystallisation by the common process. For, sugar cannot crystallise in the presence of a free acid, which is generated in this process. Tbe sugar boiler, in fact, would be only too glad to avoid the use of lime, as he cannot boil sugar with an alkali without decomposing one portiou of the sugar into carbonic-acid gas, which escapes into the atmosphere, and the portion which is left in the evaporating pan is discoloured by another part of the decomposed sugar, and augments the slimy, newly-formed glucose, which is treacle. Yet a first class sugar can be made from cane juice that has not been subject to the present crude process, and that, too, in the absence of lime, or of any other alkali, or, indeed, of any chemical agent whatever, and without producing treacle. The detrimental acid, which must be neutralised by lime—for other alkalis produce deliquescent salts aud damp sugar—is generated during the present process of manufacture. Of course where these losses of sugar do not occur in the shape of carbonic acid gas, which escapes into the atmosphere, and in the shape of glucose, which must be drained, as treacle, from the sugar which it contaminates aud reduces in value, there would be a larger sugar product, and we have the facts in corroboration of the argument.

What has been accomplished consistent with scientific principles, not in detached parts, but as a whole process, not by accident but by desigu, can be done again under like circumstances. We will simply allude to what we have seen done, of course in a sugar growing country. There, a quantity of actually rejected, and for the commou process positively worthless canes, having been gnawed and thrown down in the field by a colony of rats sometime previously, was passed through the mill, and the juice collected in the usual receiver. The amount of juice was common to a known quantity of sugar product hy the every-day process.

But, this juice, on being treated differently, now yielded a sugar prodnct which was, at least admitted to be 25 per cent. more than was commonly produced from that quantity of juice of their best canes of the same field. Those who challenged the possibility of making sugar at all from such canes, well knew the inevitable result by the common process, for they were the "old hands" on that estate. In a word they ridiculed tbe attempt and kept a close watch from the time of their fetching tbe canes. At the sight of a product superior in quantity and in quality to their own, they hecame unanimous to the truth, and appeared disposed to ideutify themselves with success. We repeat, this was no accidental result, but one of long study and experience. Therefore, we may presume to differ with the conclusion of our author, who says "there seems very little hope of amelioration." On the contrary, we are led to indulge the hope of a large iucrease of sugar product, at a cost which must be nominal on the current produce. We apprehend that success does not depend, as is supposed, ou the novelty, nor even the perfection of any part of the process, or of the mechanism employed, as on the legitimate reconstruction of the process, heginning witb the mill, which coutrihutes its large quota of mischief to augment the cumulative loss. It gets out all the available juice from the cane, and it does more wben it does what is positively mischievous in a chemical point of view, and the product suffers invariably and increasingly, to the end of tbe process, as a consequence.

It may be simply due from us to tbe profession, to note that the improvement of process, as it is certified to be, is entirely within the scope, design, and execution of tbe engineer. There can be no doubt it will command the proper attention of those who are interested in the success of cane sugar.

The author has certainly not spared himself in his successful efforts to render this compilation of value to all concerned in this important matter. We do not remember an author of uote, from whom he has not selected what is valuable, as well in relation to the commercial history, as also to the process which hitherto has prevailed. As we have hinted already, tbe planters are not satisfied with those serious losses, which their old hacknied process involves, and are, consequently, anxiously seeking for a better process to supersede it. We can have no doubt they will soon find and adopt it, for what has been done practically, can of course be repeated as an every day operation.

Captain Coles and the Admiralty; with an Inquiry into the Origin and Qualities of the Turret System of Armour-clad War Vessels. By The Son of an old Naval Officer. London: Longmans & Co., 1866. pp. 30.

We have here a vigorous criticism of the pretensions and performances of Captain Coles, in connection with the introduction of the turret system of war vessels; and the author proves very conclusively the truth of tbe doctrine we have long maintained, that it is to Ericsson in America, instead of to Coles in England, that we owe the invention and establishment of the turret system. It seems that Ericsson's attention was first turned to the construction of shot-proof vessels in 1826, but that it was not till 1854 that he publicly produced a design for such a vessel. In September of that year, however, he forwarded to the Emperor Napoleon a plau of an armour-clad cupola vessel, in which the cupola was turned by a steam engine, as in his monitors; and the rudder and screw were also protected in the manner since practised under the monitor system. On the other hand, it appears from Captain Coles' own published letters, that it was not till November, 1855, that he turned his attention to the subject of protected vessels at all; aud that he tben propounded the plan of a cask raft carrying a gun, which was protected against shot by a stationary shield. But in 1859, Mr. Bruuel, he says, suggested to him the expediency of placing his shield upon a turntable, which idea he adopted. The form of his shields, however, he had not yet settled. At first they were hemispherical, being a copy of the form propounded by Ericsson several years before. But on the suggestion of Mr. Scott Russell, they were made conical, and after having wandered into several other forms, aud after an experiment had heeu made with them in the armour-clad barge *Trusty*, which turned out a failure, the problem remained unsettled until upon the appearance of Ericsson's first monitor in 1862, the monitor turret was substituted by Captain Coles for his own abortive contrivances, and tbe *Royal Sovereign*, *Prince Albert*, and otber vessels, were fitted by him with turrets of the monitor configuration. The details of Ericsson's mechanism, however, were not copied by Captain Coles; and his own mechanism is so faulty tbat it has introduced fatal imperfection into the system according to Coles; and the result is, that neither the *Royal Sovereign* nor any other of Captain Coles' vessels could encounter a monitor without being suuk in the first five minutes. Tbe faults into which Captain Cole has fallen, are thus set forth iu the pamphlet before us:—

"It has already been stated that Captain Cole carries his turrets on rollers on the lower deck, and tbe turrets pass through great holes in tbe upper deck, with an annnlar opening between the deck and each turret. It has further been already shown, that with tbese great openings in the deck, and without any provisiou such as the mouitors have for drawing the air required for the furnaces and for ventilation from a point adequately elevated above the water, he canuot keep his upper deck very low, and that high sides are only another form of expression for thin armour. Since, too, the portions of the turrets below deck are not protected by armour at all—except that on the outside of tbe ship, a single well-directed heavy shot might smash up the gearing of all the turrets at once, and disable the vessel altogether. But these do not constitute all the objections. Those who have had the opportunity of observing the effect of shot upon the monitor turrets know very well that a large quantity of iron debris is collected at the base of each turret, consisting of fragments of halls and shells, whicb, heing broken up on the face of the armour, the fragments are projected in every directiou with great force. Now, supposing Captain Coles' turrets to be strong enough to intercept the balls and break them up, as is done hy the turrets of tbe monitors, the first effect of a hostile fire in going into action would be to jam the turrets altogether; for those fragments would be inevitably projected through the frail leather covering downwards into the annular spaces between the deck and the turrets, aud some of the fragments would there stick fast aud jam the turrets so that they could no longer be moved. The same effect would be produced by a heavy shot striking the deck where a turret passes through it, and in all its most vital points, tbe mechanism for manœuvring the turrets is mecbanically defective. In some cases this mechanism consists of a circular rack, attached to the lower deck, into which a pinion works, driven by gearing at the circumference of the turret, and moving with it, wbile iu other cases the circular rack is attached to the inside of the turret, and is moved by gearing fixed upon

the deck. Both plans are faulty; for it is found that when a turret is exposed to the shock of heavy ordnance, there is not the least certainty that it will preserve a truly cylindrical form, and if it becomes oval or otherwise distorted the gearing will not work. In the monitors, all inconvenience from this cause is obviated by turning round the turret by means of a central vertical shaft or spindle, the wheels attached to which will not be disturbed by any change in the external form of the turret, or by the concussion it suffers, and on this central pivot or spindle a considerable part of the weight of the turret is suspended. The monitor turrets have no rollers, but revolve on a ring inserted in the upper deck, and as ample means of lubricating the rubbing surfaces are provided, and as any desirable portion of the weight may be carried by the central shaft, the rotation of the towers by donkey engines provided for that purpose, is easily accomplished. Such an arrangement obviates all risk of the turret jamming by splinters, and it will continue to work efficiently if it ceases to be round. In the turret of the *Dictator*, which is 15in. thick of iron, the donkey engines which rotate the turret are capable of exerting a force of 70,000lbs. applied at its circumference, and this would suffice to turn the turret even if none of the weight were carried by the central shaft. Generally, however, the step of the central shaft is keyed up in going into action so as to support about two-thirds of the weight of the turret and guns; and in going to sea it is let down a little, so that the rubbing surfaces may form a water-tight joint. Vessels thus constructed are known to be shot-proof, and during the recent civil war in America they have been hit several thousands of times by an enemy using the most powerful guns that Europe could furnish, without having suffered material injury. That such vessels are both healthy and seaworthy, and that their 15in. guns are able to destroy 6in. armour plates with ease, the extracts from official documents, which I append to these observations, sufficiently demonstrate, and instead of pottering longer with Captain Coles, what it behoves the admiralty to do is to look the facts of the American experience fairly in the face and to resolve that neither in power of guns nor in efficiency of armour, we shall remain inferior to any nation in the world. Already other nations are taking the lead of us in this momentous race. The Baltic is swarming with monitors; and on the occasion of a recent visit paid by the Grand Duke Constantine of Russia to the King of Sweden, he was attended by a fleet of ten monitors, built from copies of the drawings from which the American monitors have been built. Swedish monitors on the American pattern also now navigate the Baltic; and very soon a number of Norwegian monitors, at present being built, will navigate the North Sea. Numbers of 15in. guns are now being cast near Stockholm. Russia is arming herself largely with similar ordnance; and it is quite imperative that England shall not lag behind in the career of improvement, and subject herself to the risk of being bearded at her doors. We are all too apt to sink into complacency at the contemplation of our own perfections; and undoubtedly during the last few years we have done wonders in the progress we have made. But we certainly have nothing which we could oppose to such a vessel as the *Dictator*, with her 15in. guns, turret 15in. thick, of solid iron, and side armour 11in. thick, backed by several feet of oak. Whatever we do now in the way of turret vessels should be an improvement upon that. We should begin where the Americans left off—utilising their precious experience, and carrying the principles they have proved to be sound and effective to a still more advanced development. Doubt is inadmissable where certainty can be obtained; and even if Captain Coles' arrangements were to all appearance as perfect as those of Ericsson, they would nevertheless be less eligible, for the simple reason that they are still untested in actual war."

In an appendix at the end of the pamphlet, is given a number of extracts from American official papers, showing that the 15in. monitor guns can easily break up 6in. armour plates with thick oak backing, and that the Americans do not consider 15in. thickness of armour to be too much for the turrets of their monitors, and 11 or 12in. with 4 or 5ft. of oak backing to be too much for the sides, those being the thicknesses they have actually adopted. It is also stated that the United States government has a a park of Rodman's 20in. guns, discharging 1,000lb. spherical shot, and that such guns will be carried by the monitors. Most conclusive proof is also given from the results of actual experience of the eminently seaworthy qualities of the monitors in heavy storms, and of their greater healthiness than common vessels, while the monitors after having been in action more frequently during the civil war than any vessels recorded in history, and having been hit several thousand times by shot projected by an enterprising enemy, from the most powerful guns Europe could supply, were unharmed at the end of the conflict, and at the present moment are quite effective.

The author of the tract before us, goes into the question of the dispute Captain Coles has had with the Admiralty, and shows that Captain Coles while unable to render to the Admiralty any useful service, has been continually attacking and misrepresenting the plans and proceedings of his brother officers at the Admiralty, who were debarred by the reticence imposed by their official position, from returning any answer to him. The Admiralty, who had retained the services of Captain Coles to advise in the construction of turret vessels, being of opinion that it was inconsistent with proper discipline, and was unjust to their other servants, that such a state of things should continue, after having borne the annoyance for some time, at length dispensed with Captain Coles' services; which, seeing that he possesses no knowledge which could aid the Admiralty in the solution of an important mechanical problem, it was an error to have engaged. The author also confutes the misrepresentations respecting Mr. Reed's ships, which have been so industriously promulgated by Captain Coles and his friends, and shows that those vessels are a great improvement on anything we possessed before, while Mr. Reed's accession to office has introduced unprecedented efficiency and vigour into the constructive department of the navy. Into these various points, however, we cannot at present enter, but we recommend those who take an interest in them to peruse this telling pamphlet for themselves. The partizan character which the controversy had assumed, and the fact that while Captain Coles was free to make any statement he liked, those who could best confute him were prevented from saying anything to dispel the delusions he laboured to create, have necessarily led to much popular misapprehension, and hence such an exposition as the present was much needed to rout out the fallacies which have heretofore prevailed. That Captain Coles will be able to answer this pamphlet, we do not for one moment expect. But it is quite incumbent upon him to make the attempt if he would avert the doom of collapsing immediately into the insignificance from which he lately emerged.

BOOKS RECEIVED.

In addition to the above, we have received the following works, but are compelled from want of space to defer our notices of them until our next issue :—

"Technological Education." By J. W. Nystrom. Philadelphia: H. C. Baird, 406, Walnut-street.

"The Engineers', Architects', and Contractors' Pocket Book." London: Messrs. Lockwood and Co., Stationers' Hall-court.

"The Builders' and Contractors' Price Book for 1866." By G. R. Burnell, Esq. London: Lockwood and Co., Stationers' Hall-court.

"The Year Book of Facts for 1866." London: Lockwood and Co., Stationers' Hall-court.

"The Geology of Leicestershire." London: Nichols and Sons, Parliament-street.

NOTICES TO CORRESONDENTS.

J. Williams.—Take Webster's definition and you will be correct, viz., One of the names of silicic acid in a state of purity.

A.H., C.E. (Manchester).—If our correspondent will favor us with his address, it will enable us to write to him, and receive particulars to substantiate the statement made by him in his letter of grievance, written, doubtless, he believed, in our interests.

One who is "So exceedingly fond of Science."—Regret we cannot minister to your cravings in our present issue.

A.J. (Newcastle).—Reservoirs are lined according to circumstances of soil, &c., the most perfect are constructed with an upper layer of bricks on edge, laid at an angle of 45 deg. to the perpendicular, under which is another similar layer at right angles to the upper, the whole being backed by concrete and puddle.

L. M. (Winchester).—The human voice is audible in the still air, at a distance of ·087 miles.

The Winan's Yacht.—We have previously, from time to time, given detailed accounts of the cigar-shaped ship, hence we shall not now reiterate our description of that curious vessel. The principles upon which it is constructed we have very recently analysed, and at the present time we have only to notice the fact that the yacht has been launched. The deck of the vessel is 4ft. 10in. high, 130ft. long, 10½ft. broad, and this, with the funnel, masts, and a small part of the upper curve of the paraboloid of the vessel, were all that were seen out of the water when she had glided into the Thames. Mrs. William L. Winan named the vessel, christening it the "Rose Winan." The launch was in every respect successful, the vessel carrying the flags of England, America, and Russia. We now look forward with interest to the trial of Mr. Winan's yacht; being as it is a bold trial of a new principle, it cannot fail, under any circumstances, to afford very valuable information on the important subject of ocean navigation, and we sincerely wish that Mr. Winan's long and diligent endeavours may ultimately be crowned with success.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Feb. 3.			Feb. 10.			Feb. 17.			Feb. 24.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	99	0	0	99	0	0	99	0	0	99	0	0
Tough cake, do.	96	0	0	96	0	0	96	0	0	96	0	0
Copper wire, per lb.	0	1	0½	0	1	0½	0	1	0½	0	1	0½
„ tubes, do.	0	1	1¼	0	1	1¼	0	1	1¼	0	1	1¼
Sheathing, per ton	101	0	0	101	0	0	101	0	0	101	0	0
Bottoms, do.	106	0	0	106	0	0	106	0	0	106	0	0
IRON.												
Bars, Welsh, in London, per ton	7	10	0	7	10	0	7	10	0	7	10	0
Nail rods, do.	8	15	0	8	15	0	8	15	0	8	15	0
„ Stafford in London, do.	9	0	0	9	0	0	9	0	0	9	0	0
Bars, do.	9	0	0	9	0	0	9	0	0	9	0	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	10	0	10	10	0	10	10	0	10	10	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	3	6	9	3	8	6	3	11	0	3	16	0
LEAD.												
English pig, ord. soft, per ton	21	15	0	21	15	0	21	15	0	21	0	0
„ sheet, do.	21	15	0	21	10	0	21	10	0	21	0	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	20	10	0	20	5	0	20	5	0	20	0	0
BRASS.												
Sheets, per lb.	0	0	11	0	0	11	0	1	11	0	0	11
Wire, do.	0	0	10½	0	0	10½	0	0	10½	0	0	10½
Tubes, do.	0	0	11¾	0	0	11¾	0	0	11¾	0	0	11¾
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	18	0	0	18	0	0	18	0	0	18	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	8	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	15	0	1	15	0	1	15	0	1	15	0
IX „ „ „	2	1	0	2	1	0	2	1	0	2	1	0
IC „ 2nd qua., „	1	13	0	1	13	0	1	13	0	1	13	0
IC Coke, per box	1	8	0	1	8	0	1	8	0	1	8	0
IX „ „	1	14	0	1	14	0	1	14	0	1	14	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Act of Bankruptcy.—It has been decided by the Lord Chancellor, in re Colemere that an assignment by a trader of all his property is not necessarily an act of bankruptcy, unless it be for the purpose of favouring some particular creditor, or for the purpose of paying all the creditors otherwise than through the instrumentality of the Court of Bankruptcy. The Lord Chancellor, referring to the Bankrupt Act of 1849, said :—"The Act of Parliament says that 'if any trader shall make, or cause to be made, any fraudulent grant or conveyance of his lands, tenements, goods, or chattels,' and a variety of other things, 'he shall be deemed to have thereby committed an act of bankruptcy.' This enactment is a substantial repetition of a very old enactment, for although this was passed in 1849, it was what had gone on for a century before. From the time of James I. it was held that any assignment made by a trader of all his goods was necessarily a fraudulent assignment, because it prevented him from carrying on his trade. Therefore, whenever a trader had assigned all his goods, he had necessarily committed an act of bankruptcy. But, in comparatively modern times, a very reasonable qualification has been introduced—that the assignment must be an assignment not for the purpose of raising money to enable him to go on with his trade, but for the purpose of paying some favoured creditor, or all his creditors, other than through the instrumentality of the Court of Bankruptcy. In either case it was an act of bankruptcy. But if it was for the purpose of enabling him to raise money to go on with his trade, that cannot be called a fraudulent act, as tending to defeat and delay his creditors. It probably was, and might have been, the wisest step he could have taken to promote the interests of his creditors. That being so, many cases have arisen in modern times of the application of these principles to the enactment as contained in the bankruptcy statutes." This case was heard on an appeal on the part of Anne Colemere, of Ellesmere, Shropshire, grocer, against an order of adjudication made by Mr. Commissioner Sanders, at Birmingham, whose decision the Lord Chancellor has now reversed.

Composition Deeds.—The Lord Chancellor, in re Stark, referring to the case of Whitacre v. Lowe, said that, although he considered the view taken by Lord Westbury to be the reasonable and correct one, he felt himself bound by the express decision of the Court of Exchequer Chamber, after the question had been carefully considered by the judges; and he, therefore, held that in reckoning whether a "majority in number representing three-fourths in value of the creditors," had assented to a deed under section 192 of the Bankruptcy Act, 1861, the secured creditors were to be counted without deducting the value of their securities.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Steam-Hammers.—According to the invention of Mr. James Dodge, of Manchester, the object of which is to enable the workmen to prevent the falling of the hammer at pleasure, and for any period of time required, it is proposed to apply a catch, which passes under the hammer when it is elevated, and, therefore supports itself in its raised position. To this catch he connects a treadle or lever, by which the catch may be removed when the hammer is to fall.

Damper Regulator.—An ingenious and useful machine has been invented by Mr. Clark, of New York, by which the fire is controlled by the pressure of the steam in the boiler, which, after an experience of years in most of our manufacturing establishments, is proved to possess invaluable features unattainable by any other device. By its use the steam is always kept at a uniform pressure, it saves great bars and furnace fronts, besides preventing the straining of the boiler, and withal saves at least 12½ per centage in fuel, a matter of prime importance when coal is held at its present high price. In fact, it is an ever faithful, always reliable, automatic watchman. Thousands of these regulators are now in practical use.

Improved Safety Gunpowder.—Mr. L. H. G. Ehrhardt, of Bayswater, proposes the use of tannin, or such substances as contain this material in large proportions, such as cachecu gum kino, coal, mineral, or vegetable carbon, &c., in combination with either chlorate of potash or other fusible chlorates, or nitrate of potash singly or in combination. The proportions of the above ingredients will vary according to the effect desired; thus, a good blasting powder may be made by using—1. Chlorate of potash, 1½ part; nitrate of potash, 1½ part. 2. Cutch, one part; cannel coal, two parts, all by bulk. The whole of the materials are finely powdered—the two compounds are kept separate until required for use, and are then thoroughly incorporated. For military and sporting gunpowder he employs chlorate of potash, four parts; tannin or cutch, one part by weight; the whole finally powdered. For explosive shells and similar projectiles, chlorate of potash, six parts; tannin or cutch, one part. Whilst the compounds are separate they are inexplosive.

Desulphurising Coal.—Mr. Charles F. Dennet, who for 12 years was the active agent of Colt's Fire-arms Factory Company in this country, is about introducing a new method for the treatment of coal, which has been pronounced a decided success. The coal prepared by the new process, which is very simple and cheap, is said to be far superior to coke for melting iron, &c. A much better fire can be made with it than with coke. Cast-steel heated by coal thus treated has been welded without the use of borax or other ingredients. Pig-iron, which has been found too hard, has been found to yield and produce as good work as turned out with some of the best brands of iron. Crystallised iron, after melting once or twice in a cupola with the desulphurised coal prepared by the new art, has been found to work exceedingly well. The whole apparatus and ingredients to treat 100 bushels of coal can be put up for from £5 to £10, and it is stated that 60 bushels prepared by this process give as much heat as 85 bushels of the best coal not so prepared. The coal burns with a bright and violent blaze, and for family use effectually gets rid of the smoky smouldering fires, and substitutes one of a bright and cheerful character. To smiths and manufacturing establishments, where large and strong fires are kept up, it is proposed to grant rights for usage at such low rates as to ensure its general adoption, and do away in great measure with the smoke nuisance so injurious everywhere.

Anti-friction Centrifugal Pump.—The improvement recently introduced by Mr. W. D. Andrews, of New York, will, it is claimed, render the anti-friction centrifugal pump of far greater practical utility. From a careful study of the law upon which the centrifugal pump is constructed, and the consideration of the fact that sudden changes of motion consume power, Mr. Andrews was led to the idea so to construct his pump that a continuous supply of water is conducted to the rotating disc, having wings projecting from its surface, and by means of spiral passages is delivered to it in the line of its motion, and in escaping from the wheel is by means of the spiral delivery passage again, by an easy and gentle curve, brought back to a straight line when it emerges from the pump. No sudden change is given to the current at any portion of its course, but by the peculiar construction the water, entering the pump at right angles by the motion of the rotating disc, is by long spiral passages turned from its direct forward course, and delivered to the disc in the line of its motion. The disc is a truncated one, considerably smaller than the case within which it revolves, but having wings upon its periphery, extending across and sweeping the space between it and the ease. When the disc is set in motion, the water upon its surface and between the wings has a tendency to fly off in a tangential line (as before explained), but meeting in its course an inclined circular surface it is again changed, by an easy spiral, back to a straight line at right angles to its entrance into the pump, when it leaves at the discharge orifice. The wings run close to, but do not touch the case, and the only part in contact to create friction is the shaft in its bearings. The result is, that the machine itself, being almost without motion, and the water pressing through the pump without sudden change of motion, a large proportion of the power is saved which is lost by a different construction.

The Largest Marine Steam-Cylinder ever cast has been turned out successfully by John Roach and Son, at the Etna Ironworks, New York City. It is 112in. in diameter, and 12ft. bore, and is for the new steamer *Bristol*, building for Sound service. This triumph of American skill gives but another proof of our advancement in the manipulation of iron in this country. We have produced the largest wrought-iron solid fly-wheel, shafts, composition screw-propeller, guns, and now the king of all steam-cylinders. With this cylinder on end, a round table placed in its centre, would accommodate about 30 people.

Steam Fire-engines.—Recently a trial of steam fire-engines, by Messrs. Merryweather, took place at the Surrey Canal, in presence of the Metropolitan Board of Works. The performance of the largest engine, formed on the same principle as the Sutherland, which gained the first prize at the International Contest, Crystal Palace, 1863, was astonishing, projecting a jet of water, of 6in. circumference, in the air 338ft. This engine is the Portsmouth, and is purchased by her Majesty's Government for service in Portsmonth Dockyard.

Liebig on Ventilation.—Liebig suggests that in close room and on ship-board deficient ventilation may be compensated for by the use of hydrate of lime. Eighteen or twenty pounds of slaked lime will absorb 38 or 39 cubic feet of carbonic acid gas, which would be immediately replaced by an equal volume of fresh air entering through the crevices. There is nothing very new in this suggestion.

London.—There are, it appears, 339 thoroughfares in the city of London, and 163 of these are only of sufficient width to allow of a single line traffic, while there are 101 which afford only a double line traffic, and only 70 which afford room for three lines or more. There are 60,000 vehicles passing daily through the City.

Substitute for Magnesium.—Science has discovered, through the skill of a French chemist, a new substitute for the new metal magnesium, which will produce a light nearly as brilliant, at a very much lower cost. The new light is produced by the combustion of a mixture of twenty-four parts of well-dried pulverised nitrate of potash with seven parts of flower of sulphur and six of the red sulphide of arsenic, and the mixture can be sold at about 3d. a pound. Professor Tyndall has been exhibiting at the Royal Institution some more of the marvellous phenomena of the connection of light and sound.

Drainage of Frankfort-on-Maine.—Frankfort-on-Maine is to be supplied with a thorough system of drainage in the English style. The civil engineers engaged by the municipality to superintend the works are Messrs W. Lindley, of London, and T. Gordon, of Carlisle.

The Institution of Engineers in Scotland.—At a meeting recently held, the following medals, awarded for papers read during the session 1863-64, were presented :—The Marine Engineering Medal, to Mr. James R. Napier, for his paper "On the Incrustation of Marine Boilers."—The Railway Engineering Medal, to Mr. John Downie, for his paper "On Renewing the Substructures of Railway Bridges and Viaducts without Stopping the Traffic."—The Institution Medal, to Mr. James M. Gale, C.E., for his paper "On the Glasgow Water Works."

Scarcity of Coal.—The weekly consumption of coal in the mines of Cornwall is something enormous. Anything, therefore, that interferes with the regular supply of this absolutely indispensable article causes grave apprehension in the mining districts. The heavy and continuous gales we have had during the past six weeks have, it may be naturally supposed, interfered with the regular arrival of vessels from the Welsh ports; and unless a speedy change should take place a famine, as far as the necessary fuel is concerned, is at the present moment really imminent. Correspondents tell us of the great scarcity now prevailing at Devoran, where the imports are usually on a very large scale. Coals had become so scarce that parties had to go out of their usual course, and have a quantity forwarded by rail from Falmouth to Perranwell Station, thence to be hauled to the Gwennap and other mines. On the north coast, at St. Agnes, they have scarcely any supply; at Portreath there is scarcely a month's supply; and at Hayle there is little or no mining coal. On the south coast, at Penzance, the stock may be said to be almost exhausted. Within the port of Truro there may, probably, be about 2,500 house and 3,000 tons of mining coal; but not more. At Falmouth, about 1,000 tons of house coal; and at Penryn, about the same quantity. At Gweek they are tolerably well off, but at Porthleven there is scarcely any mining coal. Altogether, the supply is inadequate for the immense demand, now almost doubled in consequence of the flooding of the mines from the immense quantity of rain which has lately fallen.

The Geological Survey of India has now been in operation for about ten years under Mr. T. Oldham, LL.D. as director. In the various presidencies, but especially in Bengal and Central India, its assistants have thoroughly investigated and mapped out an area more than twice that of Great Britain, or 185,000 miles.

New Artesian Well in Paris.—To the two Artesian wells which Paris already possesses, a third is now being added—at the point called Butte aux Cailles, in the 13th arrondissement (Gobelins). The perforation has now reached the depth of 82 metres, being 20¼ metres below the level of the sea; but before reaching that point considerable difficulties have had to be overcome, in the shape of intermediate sheets of water, forming as it were a series of subterranean lakes. The first of these was kept within its natural bed by means of a strong iron tube driven perpendicularly through it; that which followed received wooden palings, and the subsequent stratum being clay, the masonry was continued without difficulty to a depth of 5 metres above the level of the sea. But at this point a layer of agglomerations was reached, which let a great deal of water escape. It thus became necessary to have again recourse to pumps; those employed were in the aggregate of 20 horse-power. Owing to the bad nature of this stratum it was resolved to protect the perforation by a revetement of extraordinary thickness; and in order that the well might preserve its diameter of 2 metres notwithstanding, the upper part has had to be widened in proportion, so as to give it the enormous width of 4 metres at the top. After this labour the work of perforation was continued through a stratum of pyrolithic limestone. At the depth corresponding to the level of the sea, they reached a layer of tubular chalk, all pierced with large holes, forming so many spouts, as thick as a man's thigh, through which water poured into the well with incredible velocity. While the pumps were at work to get rid of this water, a cylindrical revetement of bricks was built on a sort of wheel made of oak, and laid down flat at the bottom of the perforation by way of a foundation, and the intermediate space between this cylinder and the chalk stratum was filled with concrete, 47,000 kilos. of which were expended in this operation. As soon as the concrete might be considered to have set, or attained sufficient consistency, the brick cylinder was taken to pieces again, and the perforation continued to the pressure point, where a new sheet of water has been reached, requiring ingenious contrivances.

Desulphurising Ores.—Messrs. Tait and Avis, of New York, have patented the process of desulphurising sulpherets by a current of heated compressed atmospheric air, impelled by a suitable pump, in combination with a closed furnace containing the ore. Also the use in this process of nitric oxide gas in combination with the atmospheric air; also the use of steam in combination with the heated air.

The Welsh Coal Trade and Birkenhead.—The development of the coal trade between South Wales and Birkenhead has been considerable within the past few months; in fact, it is growing to such an extent that some difficulty is experienced in accommodating it, notwithstanding that the Great Western Railway Company still afford all the facilities at their command. This prosperous state of things is mainly to be attributed to the sound and wise policy adopted by the Great Western Board in lowering their rates of traffic, which has alike proved beneficial to the interests of the shareholders and the coal trade of South Wales. Great, however, as has been the development, the demand for South Wales steam coal is such that there is no doubt of the trade being yet largely increased, and it found that steamers can be coaled cheaper by conveying the coal from South Wales by rail than by sending it round to Liverpool in coasters, as was formerly the case.

NAVAL ENGINEERING.

The Screw Iron-built Troopship "Simoom," 1,980 tons, 400 horse-power, made her official trial of speed, at light draught of water, over the measured mile in Stokes Bay, on the 1st ult. The ship drew 17ft. forward and 18ft. 10in. aft. She was complete in rigging aloft, but required her stores and provisions, coals, officers, and crew, as also troops to be on board to bring her down to her deep load-line or sea-going draught of water. Six runs were first made with full-boiler power, alternately with and against tide, which gave the ship's speed in each run as 11·803, 11·215, 12·203, 10·846, 12·456, 10·434 knots, the mean speed of the ship as worked out from the six runs being 11·588 knots. The pressure of steam was 20lb., the vacuum 25in., the revolutions of the engines, maximum, 62·5; minimum, 51·5. Four runs with half-boiler power gave 11·841, 7·985, 12.080, and 7·860 knots, the ship's mean speed being 9·986 knots. The steam pressure and vacuum were as in the previous full-power trials, and the revolutions of engines ranged from 25 to 52·5. With six men at the wheel with full-boiler power, and five men with half-boiler power, circles were made as follows :—At full-boiler power—Helm got up in 45 sec. to starboard, 52 sec. to port; angle of rudder, 29 deg. to starboard, 27 to port; turns of wheel, 2·5 to starboard, 2·5 to port; half-circle made in 3 min. 2 sec. to starboard, to port 3 min. 1 sec.; full circle made in 5 min. 52 sec. to starboard; to port, 5 min. 56 sec. The revolutions of the engines before the helm was put up were 62·5; afterwards, 61. At half-boiler power—Helm got up in 54 sec. to starboard, 32 sec. to port; angle of rudder, 30 deg. to starboard, 32 deg. to port; half-circle made in 3 min. 32 sec. to starboard, 3 min. 15 sec. to port; full circle made in 6 min. 59 sec. to starboard, 6 min. 31 sec. to port. The revolutions of the engines before the helm was put up were 55·5; afterwards, 52. The machinery of the *Simoom* is new, having been constructed for her by the steam factory department of Portsmouth dockyard since the period of her last commission. The engines are of the ordinary two-cylinder pattern, the cylinders having a diameter of 62½in., and a length of stroke of 3ft. They drive a two-bladed screw fitted with Maudslay's shifting blades, having a range of pitch from 22ft. 6in. to 27ft. 6in. The present pitch is 26ft., the diameter 16ft., and the length 2ft. 5¼in. The engines worked in the most satisfactory manner throughout the trial. The ship had previously made six trials at different dates between 1850 and 1856 over the measured mile, but four of these were reported at the time as imperfect from stated causes. Selecting, therefore, the two favourably reported trials of the ships, we find that on the 25th of February, 1854, the ship was tried at a mean draught of water of 17ft. 6¾in., and attained a mean speed of 7·926 knots. On the 25th of November, 1856, she was tried at a mean draught of water of 15ft. 11¼in., and attained a speed of 10·861 knots. On this occasion she was tried at a [mean] draught of water of 17ft. 11in., and attained a mean speed of of 11·588.

The "Royal Alfred," 18, partially iron-cased ship, of 4,045 tons, and 800-horse power, steamed out of Portsmouth harbour on the 17th ult., on her light-draught trial of speed over the measured mile in Stokes Bay. Six runs were made with full-boiler power over the mile, four with half-boiler power, and two circles made with full power, the results being as undermentioned. The wind was from N.N.W., at a force of two during the full-power runs, and a force of three during the half-power runs, the sea being quite smooth. The ship is not yet rigged, nor has she any stores or any part of her armament on board. Under these conditions the ship, on entering upon her first mile, drew 22ft. 10in. of water aft, and 19 ft. 9in. forward. The runs with full-boiler power, with the tide, gave the following results.—1st Run.—Speed of ship, 13·186 knots; steam pressure, 21·5lb.; vacuum, 21in.; revolutions of engines, 61. 2nd Run.—Speed, 13·284 knots; steam pressure, 17·5lb.; vacuum, 22in.; revolutions, 61. 3rd Run.—Speed, 13·740 knots; steam pressure, 25lb.; vacuum, 21in.; revolutions, 61·5. The runs against the tide gave the following results.:—1st Run.—Speed, 12·857 knots; steam pressure, 21lb.; vacuum, 22in.; revolutions, 61·5. 2nd Run.—Speed, 12·543 knots; steam pressure, 21·5lb.; vacuum, 21in.; revolutions, 61. 3rd Run.—Speed, 12·371 knots; steam pressure, 21lb.; vacuum, 21 in.; revolutions, 61·5. The mean speed of the ship at full-power was 13·166 knots. The runs with half-boiler power, with the tide, gave :—1st Run.—Speed, 12·731; pressure, 22lb.; vacuum, 22in.; revolutions of engines, 48. 2nd Run.—Speed, 10·055; pressure, 22lb.; vacuum, 22in.; revolutions, 48. Against the tide.—1st Run.—Speed, 9·022; pressure, 21·5lb.; vacuum, 22in.; revolutions, 48. 2nd Run.—Speed, 8·955; pressure, 21·5lb.: vacuum, 22in.; revolutions, 48. The mean speed of the ship with half-boiler power was 10·191 knots. In the circles to port and to starboard, with full-boiler power, the ship moving round to port. the following were the results :—Time occupied in getting up helm, 1min. 35sec.; men at wheel, 11; turns of the wheel, 3·5; angle of the rudder, 22 deg.; half-circle made in 2min. 57sec.; full circle made in 5min. 9sec. The revolutions of engines before going on circle were 61; afterwards, 59. The ship moving round to starboard gave the following results :—Time occupied in getting up helm, 1min. 15sec.; men at wheel, 11; turns of the wheel, 3; angle of the rudder, 23 deg.; half-circle made in 2min. 57sec.; full circle ditto, 5min. 30sec.; revolutions of engines before going in the circle, 61; afterwards, 58. The trial was thoroughly satisfactory. The speed of the ship was half a knot in excess of what had been anticipated, and the machinery worked with great regularity and smoothness. The engines are by Maudslay, Field, and Son, and of the ordinary Maudslay two cylinder description, such as are on board her Majesty's turret-ship *Royal Sovereign* and other vessels in her Majesty's navy. They are of 850-horse power, nominal, and have cylinders of 85 inches diameter and 4 feet stroke. They drive a Griffith's screw, fitted with the Maudslay shifting blades, set at a pitch of 27 feet 6 inches. the screw's diameter being 19 feet 2¼ inches, and the length of the blades four feet.

Ship's Launch, No. 10, fitted with engines by Messrs. Rennie, and driving a pair of twin screws, working independently, was tried at Portsmouth on the 23d ult. The trial of a ship's boat fitted with screw machinery can never, under ordinary circumstances, be attended with any great interest; but the boat's trial, in the present instance, was so far novel and out of the ordinary course of such trials, that each screw was driven by a single engine in lieu of the ordinary method by a pair of engines. Surface condensers were also fitted to each engine, the object in this arrangement being not so much to obtain vacuum as to supply the engine with fresh water, a feature of great importance in the fitting of these small engines. The substitution of one for the usual two cylinders in the driving of each shaft also necessarily lessens the number of parts and simplifies the general arrangement. The launch drew 1ft. 7in. of water forward, and 2ft. 10. aft. The load on the safety vale was from 75lb. to 80lb., and the pressure on the cylinders 65lb. The *maximum* number of the screw's revolutions was 304, and the *minimum* 293, The diameter of the screws 2ft. 6in., and their pitch 3ft. 6in. The mean speed of the boat in her runs over the measured mile was found to be 7·500 knots. The trial was considered to be satisfactory.

Naval Estimates.—The navy estimates for 1866-67 have been issued, and show a net decrease of £4,071 as compared with the vote for the financial year 1865-66. The totals are—required for 1866-67, £10,388,153, and—last vote for the financial year 1865-66, £10,392,224. Under the various heads there are items of increase and decrease. The most important items of decrease are—wages to seamen and marines, £82,302; victuals and clothing for ditto, £90,506; and naval stores, £377,771. The most important items of increase are—dockyards, &c., £64,776; new works, building, machinery, and repairs, £364,880; and army department conveyance of troops, £82,208. The extra receipts and repayments last year were £157,591, and they are estimated this year at £149,163, of course diminishing the expenditure to that amount.

The New Coastguard Screw Schooner "Imogen," a vessel of 300 tons, built for the Admiralty by White, of Cowes, and fitted with screw engines of 50-horse power nominal,

by Messrs John Penn and Son, made her official trial of speed over the measured mile in Stokes Bay on the 17th ult. Lieut. John B. Michell, of her Majesty's ship Asia, was in command of the vessel, and the officers of Portsmouth steam factory and reserve conducted the trial. The *Imogen* drew 12 feet of water aft, and 8ft. 5in. forward, rigged and complete for service, with all her stores on board. She attained a mean speed of 9·7 knots.

The "Lord Clyde," on the 13th ult., tested her engines and machinery at the measured mile outside Plymouth Breakwater. She was built at Pembroke from the lines of Mr. Reed, the Chief Constructor of the Navy, is 280ft. long, 58ft. 9in. broad, 20ft. 9in. deep, and burden 4,067 tons. The Lord Clyde is iron-cased, and at the trial drew 22ft. 7in. forward, and 25ft. 1½in. aft. Her engines are of 1,000 horse-power nominal, capable of exerting an indicated power of 6,000 horses, being a multiple of six to one. Steam is worked expansively, the aggregate heating surface is 19,000 square feet, and grate surface 700 square feet. The following were the results of the runs:—Mean speed of six runs, 13,312 knots; *maximum* revolutions 58½ per minute, mean 58; steam on engines 26lb., vacuum 26; pitch of screw 21 feet, diameter 23 feet; half-power speed, 11·565; *maximum* revolution 48, mean 47½; wind N.N.W., force two to four; sea smooth, with a light swell. On this occasion she drew 4½ inches more than on the previous trial, when only two runs were made, a speed of 13·553 knots per hour was then attained. The *Lord Clyde* went round the circle in 5min. 20sec., the diameter being 526 yards. This ship is constructed with a long protruding prow, armed with a heavy mass of metal.

Naval Appointments.—The following have taken place since our last:—F. C. Alton, chief engineer, to the *Doris*; J. P. Taplin and W. R. Leeson, engineers, to the *Doris*; G. Metcalf, engineer, to the *Indus*, for charge of the engines of the *Ripple*; G. Tyrer, second-class assistant-engineer, J. T. Trickett, acting second-class assist.-engineer, W. H. Keats, first-class assistant-engineer, to the *Prince Albert*; J. Morris, chief engineer, to the *Fisgard*, for service in the *Antelope*; R. Madge, chief engineer, to the *Fisgard*, for service in the *Zebra*; R. E. Horne, chief engineer, to the *Cumberland*, for service in the *Collingwood*, vice Urquhart; W. F. Capps, chief engineer, to the *Fisgard*, for service in the *Foxhound*; J. Stocks, first-class assistant-engineer, to the *Indus*, for service in the *Vestal*; L. Swift, chief engineer, to the *Cumberland*, for service in the *Rodney*; W. Anderson, chief engineer, to the *Asia*, for service in the *Victor Emanuel*; G. Paul, second-class assist.-engineer, to the *Star*; P. Baldwin, engineer, to the *Prince Albert*; W. J. Hancock, A. Kedward, and T. J. Richards, first-class assist.-engineers to the *Prince Albert*; A. Leitch, first-class assist.-engineer, additional, to the *Doris*; G. Paul, second-class assist.-engineer, to the *Cumberland*, for service in the *Wildfire*; T. W. Curtis, acting second-class assist.-engineer, additional, to the *Doris*; H. M. P. Pellew, acting second-class assist.-engineer, to the *Star*; J. Knight, first-class assist.-engineer, to the *Topaz*.

STEAM SHIPPING.

Steam Shipbuilding on the Clyde.—Messrs. Blackwood and Gordon have launched a screw of 600 tons, builders' measurement, on their own account. The dimensions of this steamer, which has been named the *Octavia*, are—length, keel and forerake. 197ft.; breadth of beam. 27ft.; depth of hold, 14ft. 9in. The vessel is now receiving her engines, which are on the inverted direct-acting principle, and of 90-horse power. The *A. Lopez*, built by Messrs. W. Denny and Brothers for Lopez and Co., of Alicante, and intended as an addition to their fleet plying between Spain and the West Indies, has "run the lights" to the satisfaction of those concerned. In this trial trip the *A. Lopez* attained a speed of rather more than 13½ knot per hour—a rate in excess of that guaranteed. The *Mary and Ella*, originally built by Messrs. Caird and Co. for the Wemyss Bay Steam-packet Company, and afterwards sold for a blockade-runner, has come round to Greenock from Liverpool. She has been taken into Messrs. Caird's graving dock, where she will be thoroughly overhauled, and fitted up as as a passenger steamer to run on the Clyde during the summer.

LAUNCHES.

The Iron Barque "Kenilworth."—On the 3rd ult., from the yard of the Preston Iron Ship-building Company, was launched the iron barque *Kenilworth*. She is 175ft. long, 29ft. beam, 21ft. hold, and of 705 tons, builder's, 701 gross register, class AA., built for Robert Hickson, Esq., of Birkenhead, for the Liverpool and San Francisco trade. The above company have, at present, six other vessels on the stocks of large tonnage.

Launch of the "Mataura."—On the 17th ult. a large company assembled at the graving docks of the Millwall Iron Works and Shipbuilding Company to witness the launch of this very fine steamship. The *Mataura* has been built for the Panama, New Zealand, and Australian Royal Mail Company, and is one of several vessels appointed to accelerate the mail service between England and New Zealand by ten days. Her length between perpendiculars is 285ft. She has a breadth of beam of 35½ft. and is nominally of 350-horse-power, and of 1,767 tonnage.

TELEGRAPHIC ENGINEERING.

Telegraphic Reform.—A petition on this subject is to be presented to Parliament by Mr. M'Laren, one of the members for Edinburgh. The petitioners "complain not only of the high rates charged by the existing companies for the transmission of messages of frequent and vexatious delays in the delivery, and of their inaccurate rendering, but also that many important towns, and even whole districts are unsupplied with the means of telegrapaic communication." They suggest that "the existing companies might be amalgamated under the sanction of an Act of Parliament, which might fix the maximum rate or rates of dividend and a moderate maximum of tariff. Another means of effecting improvement will be the passing of a general Act authorising, under proper regulations for the public interest, the erection of telegraphic posts along any public way throughout the United Kingdom. A third mode would be by the Government assuming the management of telegraphic communication, and extending the lines, so that they might at least include all the more important towns and villages—such, for example, as have money-order offices. The successful result of the reduction of the rates of postage, and the close analogy between the post-office and telegraphic system, justify the expectation that the adoption of a uniform tariff—say of 6d. for 20 words—would, within a few years, leave a surplus revenue, while it would be also a great boon to the community." The petitioners "earnestly desire that a Royal Commission should be appointed to inquire into the present system of telegraphic communication, with a view to its improvement."

Telegraphic Progress.—It is proposed to form an association to lay down a line of telegraphic wires from London, through Scotland, Shetland, and the Færoe Islands, to Iceland and the western shores of Greenland, across Davis Straits, to the coast of Labrador or Belle Isle, and to communicate through Canada with the vast telegraphic system of the United States and the continent of America. The distances between the stations are, proximately, Scotland to the Færoe Islands, 250 miles; Færoe to Iceland (Beruford), 240; Iceland to Greenland, 743; Greenland to Labrador, 507; Labrador to Canada (land line), or Greenland to Belle Isle (sea line), 210. The longest stretch of the route would thus be little more than 700 miles. A pamphlet has been issued giving an account of the project and the operations of scientific and other authorities on its practicability. By selecting the stations carefully in sheltered positions, where only the line will go out of deep into shallow grounds, it is believed that ice will be no hinderance to the accomplishment of the project or the working of the line. The Russian journal, the *Messenger*, announces that Mr. Collins, one of the directors of the Russian-American telegraph line, has given, in a public meeting, some further details of that gigantic undertaking. The line will encircle the globe if a submarine telegraph can be made between London or Paris and New York; otherwise the communication between Paris and New York must be made by the Russian-American telegraph, which runs across Behring's Strait. There are hopes that this line may be terminated in 1867.

Australian Telegraph.—From the official report of Mr. E. C. Cracknell, the superintendent of telegraphs in South Wales, to the Colonial Parliament, it appears that the length of telegraph lines at present in work throughout the Australian colony of South Wales is 2,520 miles, with 3,047 miles of wire, which on the completion of the lines in progress will be increased to 2,990 miles of line and 3,517 miles of wire. The total cost of the lines in operation on the 31st of December, 1864, not including expenditure by the colonial architect, was £132,025. The net profit for the year was 6 per cent. The lines in this colony during the summer months appear to be much more affected by lightning than those in the neighbouring colonies; and it frequently occurs that not only the lightning conductors, but the relay coils, are fused by the intensity of the atmospheric charges. To guard against this wholesale destruction Mr. Cracknell has arranged a simple cutting-out switch, which completely disconnects the conductors and instruments from the line, leaving only the main battery in circuit. This plan, he says, has been found to work very satisfactorily, and has saved the destruction of many instruments, and the consequent delay of business at the several stations so visited.

RAILWAYS.

Mont Cenis Railway Company.—The prospectus has been issued of the Mont Cenis Railway Company, with a share capital of £250,000 in shares of £20. The line will be forty-eight miles from St. Michel, in Savoy, to Susa, in Piedmont, and will overcome the elevation of that portion of the Alps by the use of the centre rail system with which our readers are familiar. The undertaking is based on very favourable concessions from the French and Italian Governments, after a full investigation of all its details by commissions of engineers specially appointed by both countries, as well as by the English, Russian, and Austrian Governments. The link of forty-eight miles thus to be supplied will complete the railway route from Calais to Brindisi on the Adriatic, and have an important influence on our future means of communication with India.

Underground Railways for Paris.—M. Edoux, civil engineer, proposes to effect as great a revolution under that city as M. Haussman, the Prefect, has done above ground. His plan is to construct a system of subterranean railways diverging from the Palace Royal as the common centre, and connected at their ends by an outside circle. One line is to go down the Rue de Rivoli, under the Place de la Madeleine and the Rue Tronchet to the railway terminus of St. Lazare; another is to go under the central Market-halls, and thence either under or over the Seine to the terminus of the Orleans Railway. From the Market-halls a branch is proposed to be carried under the Boulevard de Sebastopol and the Boulevard de Strasbourg to the termini of the Northern and Strasbourg Railways. A second branch is to go under the Boulevards and the Place de la Bastille to the termini of the Vincennes and the Lyons Railways; and finally, a line is projected from the Palais Royal, under the Champs Elysées, to the Bois de Bouloge.

The Junction of the South Western Railway with the Metropolitan Extension of the London, Chatham, and Dover at Clapham is expected to be opened for traffic on the 1st of March. By this, and the connection it will form between Ludgate-hill station and Clapham Junction, *via* Brixton and Camberwell, a new system of trains will be organised between Ludgate-hill, Twickenham, and Kingston lines.

RAILWAY ACCIDENTS.

Railway Collision on the London and North-western.—Shortly after 11 o'clock P.M. on the 22nd ult., a railway collision, which caused considerable damage to property and some personal injury, occurred on the London and North-Western Railway, half a mile south of the Euxton station. The train from London and Liverpool to the north reached Wigan at a few minutes to 11, near the time it was due, and it proceeded thence safely as far as a point known as as Euxton-bank, a short distance from the Euxton passenger station, where, unfortunately, it came into collision with a pilot engine that was at a standstill on the rails. This pilot or bank engine had in the course of the evening accompanied a luggage train from Preston to the south along the gradual ascent to the hill on the north of Wigan, where the train was left and the driver began his return journey. When about half a mile from Euxton he found he had lost a cotterill and he stopped his engine to look for it. When he came to turn on steam again he found the machinery had stopped on the "dead centre," the steam would not move the piston, and while he was in this dilemma the express from the south reached the spot, running at full speed, and a collision was the inevitable result. The bank engine was driven forward towards the station, where the night watchman leapt upon it, and applying the breaks soon brought it to a standstill. The stoker had jumped off before collision. The express engine did not escape so easily, as it was driven across the "six-foot" and upon the up-line, which it completely blocked, and several of the carriages were also thrown off the rails.

DOCKS, HARBOURS, BRIDGES.

A Wet Dock for Whitehaven.—The subject of a wet dock engaged the attention of the Trustees of the Town and Harbour of Whitehaven, at a special meeting of that body, recently held. Mr. Coode, C.E., was present, having been invited to meet the trustees. Nothing definite, however, was arrived at. A resolution was passed to the effect that the cost of the proposed dock should not exceed £100,000; and Mr. Coode was instructed to report as to the best site.

Proposed Harbour at Filey.—The Harbour of Refuge Commissioners some years since reported to Parliament that there was no place so suitable as Filey Bay for a harbour of refuge for the east coast, being adapted by nature for the purpose, and being most accessible of any bay between the Wash and the Tay. The present Government have taken no interest in the matter, and therefore what they refused to do certain capitalists propose to carry out by private enterprise, and have obtained for the purpose the Filey Pier and Orders Confirmation Bill, 1864. It is now desired to float the company, and a public meeting has been held at Filey for the purpose of getting the inhabitants to take shares to the extent of £10,000, £30,000 having been otherwise raised, and a contractor being ready to take £20,000 in shares as payment, The estimate is £100,000.

A bridge is proposed, states an American paper, to unite the cities of New York and Brooklyn by an iron bridge, extending from Chatham-square, in New York, to that part of Fulton-street, in Brooklyn, which is intersected by Clinton, or within two blocks of the City Hall. The termini will be thus more than three-quarters of a mile apart. The bridge is to be carried across the East River at an elevation of 100 feet above high water, and it is thought that but one intermediate support will be required, and that this will be erected near the Brooklyn street. The project is feasible, but the usefulness of the scheme is eclipsed by its magnitude; for it contemplates bridging one-half the city as well as the East River, as that hundreds of persons who dwell within half a mile of the river, and who are employed in New York, will have to make a considerable retrograde movement to reach their residences. The designers were more intent upon the greatness of the work than the convenience of Brooklyn, or they would not have located the terminus half a mile beyond the streets where many inhabitants reside. The proposed bridge, however, is not likely to supplant the comfortable and speedy ferry boats which at present ply between the two cities.

MINES, METALLURGY, &c.

Treating Metals and Metallic Ores.—Mr. R. M. Roberts, of Dolgelly, has patented some improvements which relate to the washing and separating of metals and metallic ores from the extraneous matters and substances with which they are ordinarily combined, and consists in an arrangement of sieves or perforated compartments on the periphery of one or more concentric wheels or rims, revolving vertically on a horizontal axis, in a reservoir of water; the several wheels or rims, when more than one are used, successively discharging their contents into those which are outside them, until the whole of the combined mass of materials, whether alluvial deposits or ore, previously crushed, has been separated and cleansed from the extraneous matters and substances with which the metallic portion is intermixed. In the case of crushed ores, the coarser and imperfectly crushed portions which are too large to pass through the sieves or perforations in the compartments, are delivered by the rims into a receptacle, from which they are conveyed to the crushers by travelling bands, and other mechanical means, to be further crushed and pulverised, and again passed through the separators. The subsident matter which is deposited in the bottom of the reservoir is discharged therefrom by scoops attached to the periphery of the revolving rims, or wheels, or otherwise, and is transferred to sloping tables, on which the metallic portions are separated and retained while the extraneous matters are allowed to pass off to the reservoirs, in which any stray portions of metal may subside, the useless matters running to waste with the current of water which accompanies them. By these means he proposes to perform the operations of washing and separating metals and metallic ores more perfectly, by recovering a greater portion of the metals, as well as more economically by the diminution of manual labour in the process described.

The Coal Trade in America.—The particulars of last year's production of the extensive anthracite coal fields of Eastern Pennsylvania is of great interest to us. The returns of the various collieries add up to 9,488,396 tons of 2,240lbs. each—a decrease of about 500,000 tons when compared with 1864. The region to which the Reading Railroad is the outlet produced 3,835,176 tons, of which nearly three-fourths were carried to market over that road. The Lehigh region produced 2,291,017 tons. The Pinegrove Collieries produced 157,840 tons, and the Shamokin 457,162 tons. The Lackawanna region produced 3,341,158 tons. Since the commencement of coal-mining operations in Pennsylvania, some 45 years ago, the enormous amount of 134,121,549 tons of anthracite have been sent to market from the Pennsylvania mines. The bituminous coal mines of Western Pennsylvania in 1865 produced 1,383,486 tons, and in order to supply the demand for this kind of coal, although in the face of a high duty intended to be prohibitory, 685,052 tons of bituminous coal were imported. In 1820, when the coal trade of Pennsylvania began, the entire annual product was only 365 tons—1 ton a day. Now a single railroad—the Philadelphia and Reading—has brought to market 100,000 tons in a single week. The only limit to the production in 1865 was the absolute inability of the various roads and canals to carry the coal from the mines, and the prospective trade of the anthracite region in 1866 is estimated at 11.000,000 tons.

Australian Gold.—It is worthy of note that the receipts of gold from Australia, which had been declining for several years past, showed a tendency to revive last year. Thus, in the first eleven months of 1865 the value of the Australian gold imported was computed at £4,276,128, as compared with £2,629,766 in 1864, and £5,504,476 in 1864 (corresponding periods). The value of the gold imported from Australia in 1858 was £9,064,763; in 1859, £8,624,566; in 1860, £6,719,000; in 1861, £6,331,225; in 1862, £6,704,753: in 1863, £5,995,368; and in 1864, £2,656,971. It is, doubtless, the development of the golds fields of New Zealand which caused the imports of Australian—or rather Australasian—gold to exhibit a revival last year; at the same time, the gold production of Australia, properly so called, is maintained with difficulty. All the gold fields of New South Wales showed a decline in their productibility last year. The yield of the western gold fields of that colony in the first ten months of 1865 showed a decline of only 600oz., or about one-third per cent., as compared with the corresponding period of 1864; but the southern fields presented a diminution of 1,856oz., or 16 per cent.; and the northern a decrease of 6,501oz., or 27 per cent.

GAS SUPPLY.

Folkestone.—The dispute between the Folkestone Gas and Coke Company and the Folkestone Gas Consumers' Company has been settled. All the shares in the latter company have been bought up by the old company, and an offer has been made to supply Shorncliffe Camp with gas at 3s. 9d. per 1,000ft., provided a specified quantity is taken.

Amount of Permanent Gas obtained in the Distillation of Coal for Oils.—A correspondent writes to the *Journal of Gas Lighting* as follows:—"It may perhaps not be generally known that at however low a heat coal or cannel is distilled, there is nevertheless a certain quantity of permanent illuminating gas which refuses to be turned into oil. My own experiments in distillation for oil give from 1,000 to 2,000 cubic feet per ton as the yield of permanent gas, depending upon the heat and the quality of the cannel distilled."

New Metropolitan Gas Bill.—A bill is to be brought before Parliament in the name of the Metropolitan Board of Works, which, among many other things provides that "the maximum price at which gas shall be sold by the said gas companies or any or either of them, or by the said Metropolitan Board of Works, or district lighting board, under the powers by this Act vested in them, and each of them, shall not exceed the sum of four shillings and three pence per thousand cubic feet, for cannel gas, and the sum of three shillings and sixpence per thousand feet for common gas, provided that when the profits derived from the "works" or "undertakings" of any or either of the said gas companies shall in any years exceed the sum of five pounds per centum per annum on the capital invested therein, exclusive of the reserve fund, then the price to be charged for gas shall be reduced in proportion to such excess of profits beyond five pounds per centum per annum."

The Stafford Gas Company have declared a dividend of 10 per cent. on their old shares, and 8 per cent. on new, although they reduced their price in October last to 4s. 2d. per 1,000 cubic feet.

The Bury St. Edmund's Gas Company reduced the price of their gas in July last, from 5s. 10d. to 5s., and have now declared a dividend of 10 per cent. on old shares, and 7½ per cent. on new, besides a further sum of 2s. per share on the old shares by way of arrears.

The Redhill Gas Company have declared a dividend of 7 per cent., free of income-tax. The works require to be enlarged in consequence of the steadily increasing consumption.

Proposed Revolution in Gas Making.—The prospectus of a tentative effort to revolutionise gas making has been issued for private circulation. The promoters entitle their undertaking "The Gas Heat and Pure Light Company, Limited," and restrict their efforts now to raise a small capital for the purpose of putting two patents obtained by Mr. I. Baggs, to a practical test. The principal features of the patents are that two usable gases, hydrogen and carbonic oxide, are producible from burning coke and water; a ton of the first yielding above 40,000 cubic feet of carbonate oxide, and another ton of the coke producing, from the known decomposition, in burning coke, of the necessary quantity of water, far more hydrogen gas than 40,000 cubic feet. Both of these gases are conveyed into the same holder; and then, without further treatment for purification, which it is said they do not require, being absolutely pure, they are ready for consumption in three ways;—1st, by giving out intense heat; 2nd, yielding a pure and brilliant light entirely free from sulphurous acid, ammonia, or bisulphide of carbon; and 3rd, by furnishing working power in quantity sufficient for all manufacturing purposes. As to the mode by which the gases are produced from the retort free of impurities, we find that iron is employed in their preparation, the iron, as intended, being recoverable and useable *ad infinitum*. It is the intention of the promoters of the company and of their engineer, to construct, in the first instance, works upon a small scale, but yet of sufficient dimensions to demonstrate the thorough practicability of the invention, and its immediate usefulness as a cheap and available source of intense and controllable heat, applicable to a variety of manufactures and useful purposes, and also suitable as an ordinary medium of brilliant and economical illumination.

WATER SUPPLY.

The Belfast Waterworks.—The cost of constructing the Belfast new waterworks—that is to say, of making the reservoirs, conduits, culverts, &c., is estimated at £95,000. Besides this, there will be law, land, and engineering expenses, and a sum of £6,000 to be paid to the Marquis of Downshire for water rights. To cover all these expenses, the Town Council have applied for an Act of Parlament allowing them to borrow £164,000.

APPLIED CHEMISTRY.

Danger attendant on the Preparation of Potassium-ethyl and Potassium-methyl.—In the preparation of the compounds of sodium with ethyl or methyl there is comparatively little to fear—at any rate, if moderate quantities only be prepared at one operation. But there is the greatest danger in preparing the potassium compounds. When the replacement of the zinc by the alkali metal proceeds briskly, there is a considerable rise of temperature both in the case of sodium and potassium. From the low temperature at which potassium fuses, it very easily happens that the potassium fuses, and when once this occurs a most tremendous explosion is the immediate result.

Cheap Manufacture of Phosphate of Soda and its use in Manure.—In *Les Mondes* M. Dumas states that coprolites are now made into phosphide of iron containing from 14 to 15 (?) per cent. of phosphorus. This is done by heating the coprolites with iron ores in a reverberatory furnace. The phosphides so obtained are sent to Paris and treated with sulphate of soda, by which sulphide of iron and phosphate of soda are formed. The phosphate of soda and some magnesian salts are mixed with the contents of cesspools, whereby an ammoniaco-magnesian phosphate is produced, and all the ammonia and phosphates in the urine and fœcal matters are fixed. This plan of treatment is the invention of M. Bohlique.

Alloys of Manganese.—In Germany M. E. Prieger has commercially prepared alloys of manganese with iron or copper possessing valuable properties, and the application of which are constantly improving in number and utility. To prepare the alloys of iron and manganese (ferro manganese), he made a mixture of pulverised oxide of manganese, charcoal dust (corresponding in quantity to the oxygen of the oxide) and of metallic iron sufficiently broken up, such as minute grains of cast-iron filings or turnings of iron or steel, &c.; the mixture was put into a graphite crucible, which would hold from 15 to 25 kilogrammes, and covered with a coating of charcoal dust, sea salt, &c., then heated for a few hours at a white heat. After cooling there was at the bottom of the crucible a metallic homogenous mass, containing but very insignificant quantities of foreign bodies. Of these alloys the most important are those containing 2 equivalents of manganese to 1 of iron, and four equivalents of manganese to 1 of iron, and corresponding to 66·3 per cent., and 79·7 per cent., of manganese. Both are harder than tempered steel; they are capable of receiving a very high polish, they melt at red heat, and can be easily poured; they do not oxidise in the air, and even in water only superficially; their white colour is of a shade between steel and silver. Alloys of copper and manganese are similarly obtained; they resemble bronze, but are much harder and more durable. Alloys of tin are very fusible, durable, and easy to work; in colour and brilliancy they may be compared to silver. The iron and manganese alloys furnish a very simple means of adding to iron or steel a given amount of manganese; by the addition of from 1·10 to 5 per cent. very satisfactory results are obtained.

Thin Sheet Iron.—Protection of Iron from Rust.—We have on previous occasions reported the successive efforts of British and foreign ironmasters in the direction of producing sheets of iron of extreme tenuity. On the occasion of the meeting of the British Association, in September last, some large and very perfect sheets of iron foil were shown at the works of Messrs. Lloyds, Fosters, and Co., of Wednesbury, which weighed two grains per square inch; and we have already described the laminated metal produced by Mr. Parry, of Ebbw Vale, weighing only 1·5 grains per square inch. Since then great progress has been made by several manufactures, and sheets of iron have been prepared of the marvellous degree of tenuity indicated by the measurement of 4,800 thicknesses being equivalent to 1in. They were produced in the mills of Messrs. W. Hallam and Co., Upper Forest Tinworks, near Swansea, and are in the form of perfect sheets, measuring 10in. by 5½in., or 55 square inches, and weighing no more than 20 grs., or 0·36 grain per square inch. A noteworthy circumstance in connection with these thin sheets of iron is their remarkable degree of permanence, or power of resisting the oxidising action of the air. This protection is undoubtedly due to the continuity of the black fused layer of magnetic oxide with which these specimens are invariably coated, a fact which Mr. McHaffie, of Glasgow, has turned to useful account in a special furnace treatment, to which plates and other articles of wrought iron are subjected for the purpose of securing increased protection against air and water. The operation consists merely in imbedding the iron plates in powdered hæmatite, or other native oxide of iron, and heating to full redness for several hours, when a perfect layer of the protective oxide is formed; the plates are then allowed to cool gradually, and are found to be especially well adapted to shipbuilding purposes. Mr. McHaffie, in his paper, also claims the use of oxide of zinc for producing an adherent black film, which in this case doubtless consists of a true combination of the oxides of iron and zinc, possessing an equal, if not superior, of permanence to that which has been already mentioned.

The discovery of Petroleum in Scotland is creating much interest. It may be interesting to know the products of shale or coal and their proportions. St. John Vincent Day, C.E., Glasgow, publishes the following report:—"The mean value of the Rankinstone shale, the result of several experiments—One ton of the shale, when distilled at a low red heat, yields of crude paraffin oil, 30 gallons; of amoniacal liquor, 12 gallons. The density of the oil is 979 (water = 1,000). This high density may in part be due to the presence of some water, which it is very difficult to separate, but there is no doubt that the oil is of very inferior quality. In the West Calder district the following may (as far as that locality has yet been explored) be taken as the mean value of the distilled products of the shales:—Crude oil per ton, 39 gallons: specific gravity of crude oil, 890; oil once distilled, 34 gallons; specific gravity of oil once distilled, 862: burning oil and spirit per ton of shale, 13½ gallons; lubricating oil, 10 gallons; paraffin, 9¾ lb.; ammoniacal water, 8 gallons. One of the best shales, from Fifeshire, yields, per ton:—Crude paraffin, specific gravity, 826·6—30 gallons; ammoniacal liquor, 16 gallons. This is a shale of remarkably good quality, but owing to its rather low yield and heavy expenses connected with raising it, it is doubted if any profit could be made by distilling it. In Fifeshire there are several valuable shales, but the cost of winning some of them must for ever prove a severe impediment to their being worked with a high commercial advantage."

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated January 24th, 1866.

236 G. T. Bousfield—Looms for weaving
237 S. M. Martin, S. A. Varley, and F. H. Varley—Electric telegraph apparatus
238 G. Hinchcliffe—Covering the lists or edges of fabrics
239 J. W. Swan—Apparatus for printing from intaglio plates
240 T. Spencer—Preparation of soils
241 J. Jones—Crushing and pulverising ores
242 W. Clark—Artificial flowers
243 W. Clark—Typographic printing apparatus.
244 L. D. Phillips—Making buttons from plastic materials

Dated January 25th, 1866.

245 J. Soutter—Centres for supporting swinging mirrors
246 J. Piddington—Manufacture of boots and shoes
247 W. Winter—Feed motion for sewing machines
248 H. Cooper, T. Duffield, and A. Gibson—Improvements in pianofortes
249 G. Dyson—Driving belts for machinery
250 J. A. Castree—Looms for weaving
251 T. Marshall and H. C. Pretty—Finishing the soles and heels of boots and shoes
252 H. Gardner—Apparatus for cleansing bottoms of ships
253 F. Wise—Bearings of axles of railway carriages
254 D. Jones—Window fastenings

Dated January 26th, 1866.

255 P. E. Waddell—Signal with guards and drivers of railway trains
256 J. H. Johnson—Construction of steam vessels
257 F. L. Roux—Copper sheathing to ships
258 J. M. A. Montclar—Materials for decolorising saccharine
259 E. Ambrose and W. Braddon—Lowering boats
260 W. H. Barlow—Railway bars
261 G. T. Bousfield—Lamps for burning magnesium
262 R. A. Brooman — Manufacture of asphalted bars
263 J. H. Johnson—Apparatus for lubricating purposes
264—A. V. Newton—Mode of treating fur
265 H. Sherwood—Apparatus for treating mixed fibrous substances

Dated January 27th, 1866.

266 J. Spencer—Rolling and clod crushing
267 M. A. F. Mennons—Apparatus for compressing air
268 W. Justice and Guild—Softening fibrous materials
269 T. Drane—Manufacture of coke
270 J. Howden—Steering ships
271 S. Cook and W. H. Hacking—Apparatus for sizing yarns
272 J. H. Brown—Leather fabrics
273 R. A. Brooman—Differential screw apparatus
274 W. W. Pocock—Gas meters
275 A. B. Childs—Machinery for crushing quartz and other substances
276 H. Wilde—Communication between guards and passengers in railway trains

Dated January 29th, 1866.

277 G. de Witte—Breaks for carriages
278 W. Hersee and G. Smyth — Manufacture of printed floor cloths
279 A. Arthur—Hydraulic machinery
280 B. Farmer—Apparatus for washing, wringing, and mangling
281 J. Orr—Steam engines
282 W. R. Harris—Improvements in weavers' healds or heddles
283 J. Snider—Construction of breech-loading firearms
284 A. Chaplin—Locomotive engines for ascending steep inclines
285 W. Clark—Disengaging eye for launching boats from the sides of ships
286 J. Robertson—Machinery for cleaning watercourses

Dated January 30th, 1866.

287 J. Berrie—Improvement in the construction of Railways
288 J. B. Dalhoff—Manufacture of files
289 H. Shaw—Apparatus of communicating motion from the engine to any part of the train
290 W. Lycett—Manufacture of salt
291 J. G. Tongue—Obtaining motive power
292 E. R. Wethered—Construction of stands for bassinettes
293 S. B. Ardrey, S. Becket, and W. Smith—Apparatus for grinding spindles
294 L. Sterne—Improvements in buffers
295 A. Smith—Sewing machines
296 J. Ingram — Embossing in cameo on paper envelopes
297 C. Doughty — Distilling the grease of cotton seed oil
298 C. O. Staunton—Improvements in ordnance and carriages

Dated January 31st, 1866.

299 W. R. Lake—Revolving firearms
300 W. R. Lake—Working and treating indiarubber and gutta percha
301 C. Delafield—Manufacture of saltpetre and white lead
302 J. Miller and J. Pyle—Apparatus for cooling worts
303 R. Clayton, J. Goulding, W. Howarth—Looms for weaving
304 C. Defries—Means for securing the safety of persons travelling by railway
305 H. A. Bonneville — Manufacture of wrought iron tubes
306 H. A. Bonneville—Lighting apparatus
307 C. E. Giajola—Railway and other lamps
308 G. Greaves—Compounds for producing glazed surfaces
309 A. Dembinsky — Composition for burning in lamps
310 W. Woodward and J. Woodward — Steam boilers or generators
311 W. Darlow—Electro magnetic engines
312 H. A. Dufrene—Hydraulic steam hammer

Dated February 1st, 1866.

313 G. D. Jones—Construction of pocket for male or female attire
314 J. Mallison—Improvements in the treatment of yarns
315 E. Candler—Vessels and apparatus for drawing off wines
316 J. Macintosh—Gas pipes
317 T. Jeuks—Ornamental metallic chains
318 J. Bulluck and J. Bullock — Improvements in looms for weaving
319 J. B. Grant—Machinery for distilling and refining petroleum
320 H. C. Lucy—Connecting or fastening the ends of iron bands
321 A. Murray—Steering apparatus
322 W. B. Nation—Purification and hardening of paraffin wax

Dated February 2nd, 1866.

323 J. J. Harrison—Looms for weaving
324 D. Winstanley—Producing printing surfaces by the aid of photography
325 W. Boase—Apparatus for measuring drapery goods
326 C. H. Hoit — Obtaining adhesion of driving wheels of locomotive engines
327 W. J. Blinkhorn—Communicating between passengers and guard
328 J. C. Patrick—Construction of cutting presses
329 H. Mitchell—Travelling or fitted dressing bags
330 G. Gwynne—Treating fatty and oily bodies
331 G. Barker and C. Davis—Improvements in sewing machines
332 H. Larkin and R. Purkis — Manufacture of paper.
333 A. V. Newton—Machinery for breaking hemp and flax
334 J. H. Johnson—Springs for ladies' skirts

Dated February 3rd, 1866.

335 J. Warburton, P. Warburton, and S. Barnes—Mules for spinning
336 T. Moldcu—Furnaces for steam boilers
337 W. Mackintosh—Holding details for lathes
338 A. Horwood and C. Brumfit—Galvanic batteries
339 W. Hibbert—Improved mechanical valve respirator
340 E. Petito—Improvements in envelopes
341 J. Holliday—Red colouring mattter
342 P. A. Muntz—Furnaces for melting metals
343 E. M. Leeds—Securing the hatchways of steam and other vessels
344 R. Jobson—Moulding articles of clay
345 F. B. Baker—Dyeing and manufacturing textile fabrics
346 T. A. G. Willington—Apparatus for heating conservatories

Dated February 5th, 1866.

347 C. V. Walker—Electric intercommunication in railway trains
348 C. D. Abel—Elastic fabrics
349 C. D. Abel—Coke ovens
350 W. Spencer and T. B. Cutts—Manufacture of Valenciennes lace
351 A. Mahieux—Machine for cutting paper
352 J. Russell—Improvements in preventing oxidation
353 W. Renney—Preventing oscillation of the card in iron ships
354 D. Spink—Propelling and steering ships
355 W. S. Cluderay—Apparatus for manufacturing buugs
356 T. Spencer—Apparatus for filtering water and other fluids

Dated February 6th, 1866.

357 P. A. Godefroy— Treatment of rami or rhea fibre
358 W. Boulton and J. Worthington—Apparatus for manufacturing dishes
359 V. Rastouin—Motive power
360 J. Allen—Improvements in envelopes
361 J. Jones—Suspending trousers
362 E. A. H. Bouther—Axle boxes for railway carriages
363 R. Galley—Blast engines
364 R. Clark—Construction and lighting of railway carriages
365 T. J. Smith—Lubricating the axles of railway rolling stock
366 J. Gunner—Breech loading firearms
367 S. Holmes—Printing ink

Dated February 7th, 1866.

368 R. Sims, J. Beard, and R. Burns—Reaping and mowing machines
369 U. Scott—Various parts of railway carriages
370 E. Price—Improvements in harrows
371 C. D. Abel — Apparatus for regulating the supply of steam
372 W. Richards—Apparatus for measuring liquids
373 G. Clark—Application of machinery for manufacture of mats
374 A. H. Brandon—Manufacture of axles for railway carriages
375 J. Lewis—Meters for measuring the flow of liquors
376 J. A. Maxwell—Safety railway system
377 A. Clark—Apparatus for mortising or cutting holes
378 B. Browne—Construction of needles
379 C. A. McEvoy—Torpedoes or submarine explosive instruments

Dated February 8th, 1866.

380 S. J. Salkeld—Spring bed bottoms
381 J. Sawyer—Fire escapes
382 W. S. Laycock—Looms for weaving a certain kind of cloth
383 P. A. F. Bobœuf—Artificial coal tars and their derivatives
384 H. Deymann—Rotary steam engine
385 J. B. Atwater—Apparatus for raising or forcing water
386 J. Townsend—Preparing size
387 R. E. Higson—Ornamentation of silk and satin fabrics
388 J. Shaw and J. Whitaker—Mechanism for opening and cleaning cotton
389 R. Bond, W. J. Bussell, and B. S. Fisher—Substitute for emery
390 R. D. Clegg and D. L. Nicolas-Dauhigsyne—Improvements in pumps
391 J. Roe—Adjustable lever spanner
392 J. G. Avery — Apparatus for raising water in shower baths
393 W. Rock—Printing machines
394 H. E. F. De Briou—Compositions for preserving metals from oxidation
395 S. B. Simon—Manufacture of hats
396 J. H. Dallmeyer—Photographic lens
397 N. H. Belt—Stiffenings for the heels of boots and shoes

Dated February 9th, 1865.

398 W. R. Lake—Machine for removing the seeds from raisins
399 E. Bevan and E Fleming—Furnaces and kilns in the manufacture of glass
400 J. Sutcliffe—Top rollers used in machinery for spinning cotton
401 J. Walker—Looms for weaving
402 R. W. Armstrong — Preparing clay dust for making earthenware
403 F. T. Baker—Breech loading firearms
404 J. Rock—Carriages and waggons with movable heads
405 G. D. Davis—Machinery for working rudders
406 W. Clissold—Clutch for driving machinery
407 J. Higgins—Rings for ring and traveller system spinning
408 J. H. Johnson—Spinning and drawing rollers
409 G. F. Russell—Wheels for vehicles
410 T. Clift—Manufacture of portable chairs
411 W. N. Wynn—Improvements in travellers for warehouses
412 C. E. Giajola — Improvements in privies and commodes
413 J. Warner—Fish hooks

Dated February 10th, 1866.

414 V. T. Junod—Apparatus employed for the cure of inflammatory diseases
415 E. Seyd—Wollen damasks
416 J. J. Shedlock—Gas burners
417 J. Binns and W. Binns—Machinery to be employed in the manufacture of wires
418 J. Ryley—Apparatus to be employed in the manufacture of hair cloth
419 H. C. Clifton—Machinery for laying veneers on to surfaces
420 J. Davidson—Reefing of sails
421 W. R. Lake—Carriages and castors for sewing machines
422 J. H. Burton—Construction of breech loading firearms
423 J. Pinches—Stamping or embossing presses
424 J. Charlton and H. Charlton—Stretching woven fabrics
425 B. W. Farey—Steam engines
426 J. Huggett—Manufacture of horse nails
427 J. G. Clarke—Range ovens
428 G. Hart—Manufacture of hats
429 G. W. Cumming and J. K. Edmonds—Boilers for heating pipes by hot water

Dated February 12th, 1866.

430 J. Tomlinson — Machinery for hackling and opening hemp
431 J. Pilbrow—Applying to land liquid sewage
432 R. Wolstenholme and R. G. Rodgers—Textile fabrics
433 W. F. Cooke and G. Hunter—Machinery used in cutting stone
434 C. D. Abel—Gas and air engines
435 J. Hargrave — Apparatus for raising and discharging water
436 A. V. Newton—Port stopper
437 A. V. Newton—Machinery for manufacturing paper collars
438 C. Arnaud—Copying presses
439 F. P. Warren—Removing water from the interior of sea-going vessels
440 A. Applegath—Printing machines
441 J. A. Longridge—Apparatus for facilitating the working of ordnance

Dated February 13th, 1866.

442 A. Stoddart — Apparatus to be employed in illusory exhibitions
443 W. R. Lake—Cartridges for breech loading firearms
444 M. R. Leverson—Manufacture of gas
445 W. Young—Improvements in grates
446 J. Patterson—Machinery for cutting the pile of woven fabrics
447 S. Marland, W. H. Smith, and W. Wells—Obtaining and applying artificial heat
448 J. Townsend—Apparatus for spinning
449 C. Gilpin—Production of copper plates
450 T. Whitley—Combing wool
451 S. Drake—Combining surfaces of wood
452 W. Brown and C. N. May—Operating on straw
453 S. W. Kelly—Manufacture of rails
454—J. B. Fenby—Pumps for raising liquids
455—J. Vero—Felting the bodies of hats
456 J. Ogden and A. Rogers — Extinguishing of fires in steam vessels
457 W. R. Lake—Improvements in vices
458 F. Ransome—Building blocks of artificial stone
459 W. Cotter—Heating apparatus

Dated February 14th, 1866.

460 H. B. Young—Screw propellers
461 A. C. Kirk—Arrangements for distilling
462 S. Mason—Improvements in the manufacture of water taps
463 F. R. Wheeldon — Improvements in casting chilled rolls
464 W. Unwin—Rolling of coach spring spindle and sheet steel
465 J. Holding—Looms for weaving
466 H. E. Baron de Gablenz and H Mahler—Submarine telegraphic cable
467 R. Smith—Printing designs on paper for hangings
468 J. Barlow—Improvements in bleaching
469 M. Henry—Improvements in photography
470 R. B. Pilliner—Machinery for packing
471 J. Soames and J. K. Soames—Purifying paraffin
472 R. Napier—Building ships of war
473 H. E. Newton—Optical instruments
474 W. E. Newton—Making collars
475 W. N. Wilson—Sewing machines

Dated February 15th, 1866.

476 E. T. Hughes—Apparatus for hoisting
477 J. Rothery — Apparatus for cutting coal and other minerals
478 J. Young—Distilling coals
479 T. Adams and G. J. Parson—Slide valves
480 D. Nicoll—Electric telegraph conductors
481 A. Applegath—Printing machines
482 A. Cumming—Teaching swimming
483 A. H. Hassall—Preparation of meat for food
484 P. Ward—Preventing and removing incrustation in steam boilers
485 G. Bedson—Machinery for rolling wire
486 A. V. Newton—Generating superheated steam
487 C. Gall—Consumption of smoke in steam boiler furnaces
488 C. Mather—Preparing linen yarn
489 T. C. Boutet—New system of bridge

Dated February 16th, 1866.

490 E. Dreveton—Champagne and sparkling wines
491 W. S. Riley—Breech loading firearms
492 W. E. Gedge—Construction of carts and other vehicles
493 W. E. Gedge— Machinery for reducing the thickness of parts of calf skins
494 W. Davidson—Square topsails and topgallant sails
495 J. Paterson—Additions to sewing machines
496 P. E. Placet—Improved method of printing
497 W. Clay—Economising the heat of gas producers
498 E. J. C. Welch—Carburetting air and gas
499 J. H. Whitehead—Fabrics composed of indiarubber and cotton
500 W. Wood and J. W. Wood—Pomfret or liquorice cakes
501 J. H. Whitehead—Endless cloths
502 A. H. Linnington—Rudders and steering apparatus
503 J. H. Whitehead—Heating the feed water for steam boilers

Dated February 17th, 1866.

504 J. Fletcher—Valves for regulating the pressure of steam
505 W. B. Woodbury—Production of ornamental surfaces for jewellery
506 J. Wolstenholme and J. T. Pendlebury—Shaving and cutting metal bars
507 S. Nelson—Shuttle tongues
508 H. Willis and G. Rice — Converting rotary motion in reciprocating motion
509 H. Lea—Looms for weaving
510 M J Lopez-y-Munoz—Machinery for making cigarettes
511 J. Greenhalgh—Ornamental designs in colour upon woollen and other fabrics
512 J. Smith—Protection of trains on railways by signalling
513 J. Kidd—Carburetting low pressure superheated steam

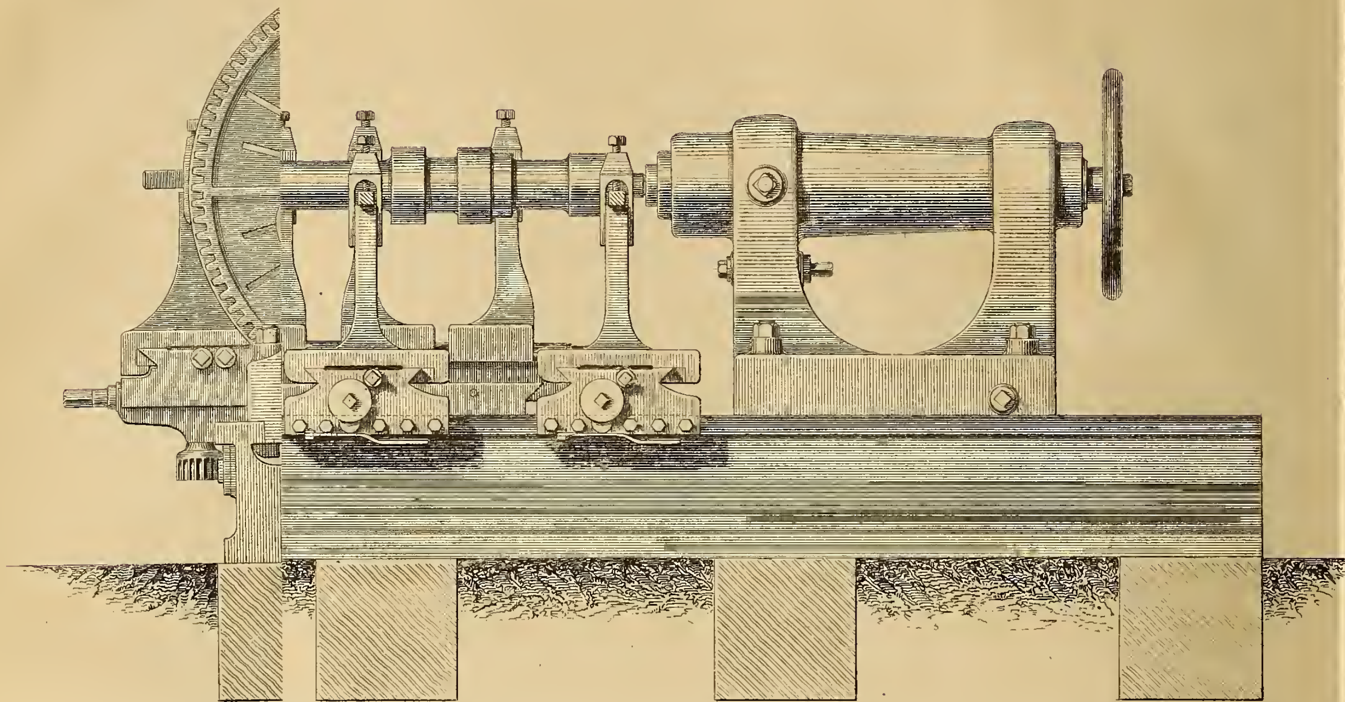
Dated February 19th, 1866.

514 M. A. Muir and J. McIlwham—Fence, gate, and telegraph posts
515 J. Whalley—Cutting fustians
516 P. Smith—Weighting top pressing rollers

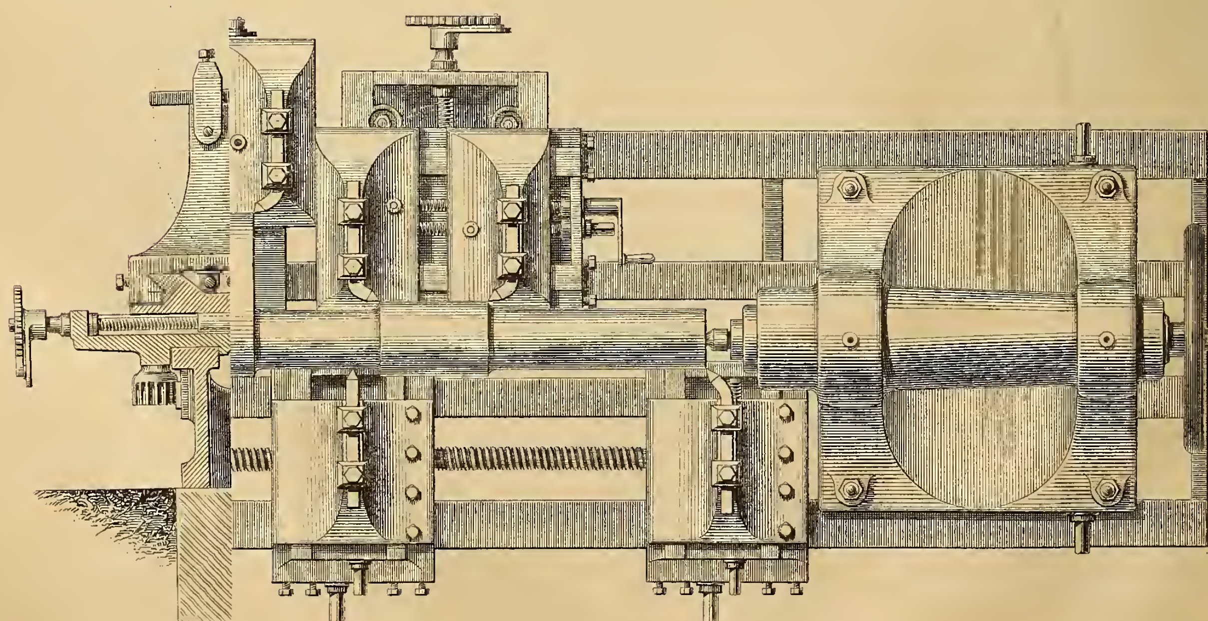
Dated February 20th, 1866.

517 J. Nall—Name plates on metal
518 E. M. Du Buys—Measuring the flow of water
519 J. H. Walsh—Breech loading guns and rifles
520 T. Kennedy—Water meters
521 A. Moore—Communicating power from place to place
522 G. Hill and D. Hill—Improvements in trusses
523 T. Williamson and E. P. Marreu — Improvements in valves
524 J. A. Warwick—Railway signals
525 J. Barry—Improved dye
526 C. E. Winby and F. C. Winby—Construction of railway wheels
527 A. B. Childs—Roasting Coffee
528 W. M. Wells—Harvesting machine
529 W. E. Newton—Breech loading firearms
530 H. P. Swift — Propelling ships by hydraulic pressure
531 A. H. Robinson—Crabs or Winches
532 H. A. Bonneville—Tubular boilers
533 W. E Gedge—Arrangement of steam boilers
534 W. R. Lake—Pocket rules
535 W. R. Lake—Improvements in drills

THE.



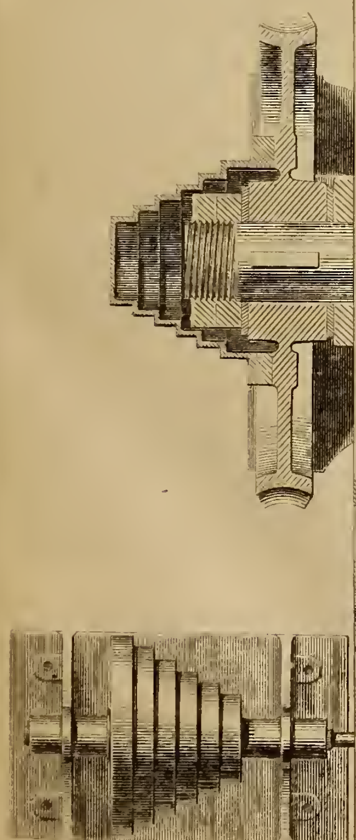
FI(SIDE ELEVATION.



PLAN.

F

W. Smith C.E. direx



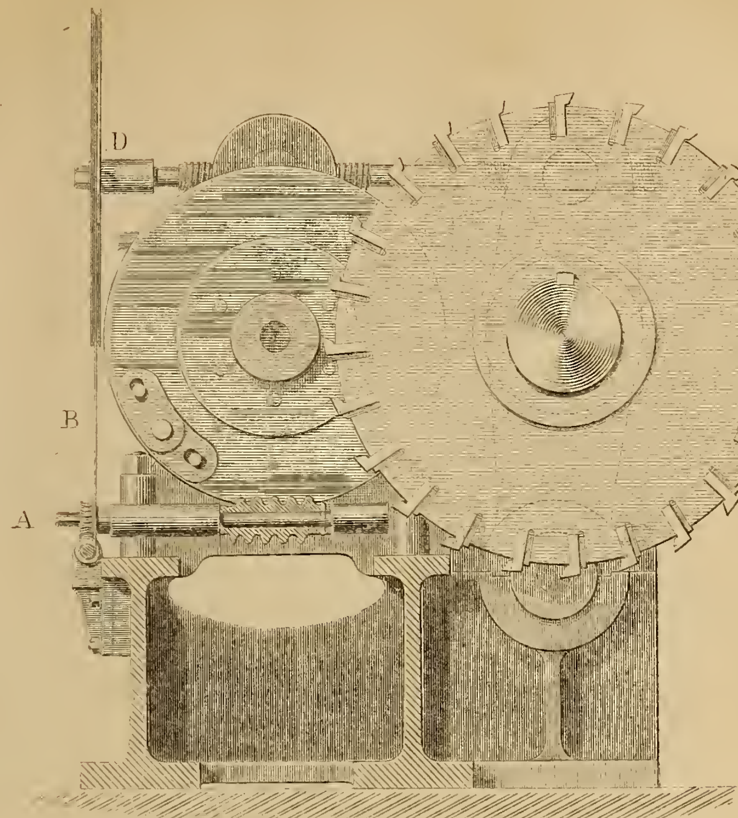


Fig. 3. Section at A.B.

Fig. 4. End Elevation.

W. Smith C.E. delin.

SHARP'S 7 TOOL CRANK AXLE LATHE.

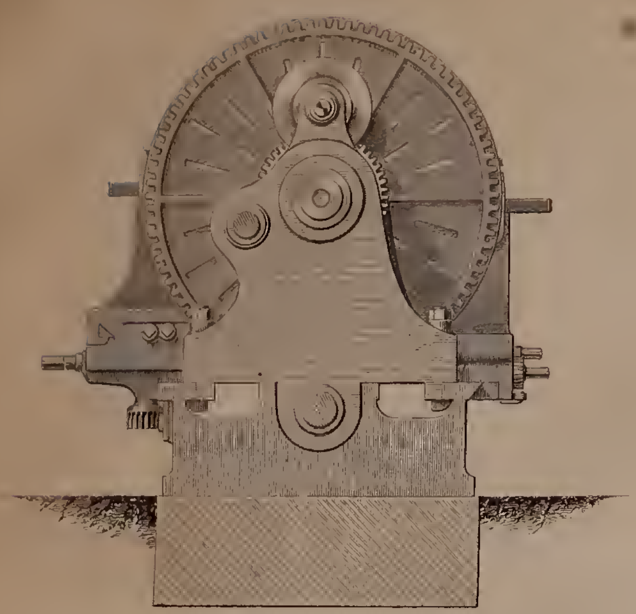


FIG. 3. END ELEVATION.

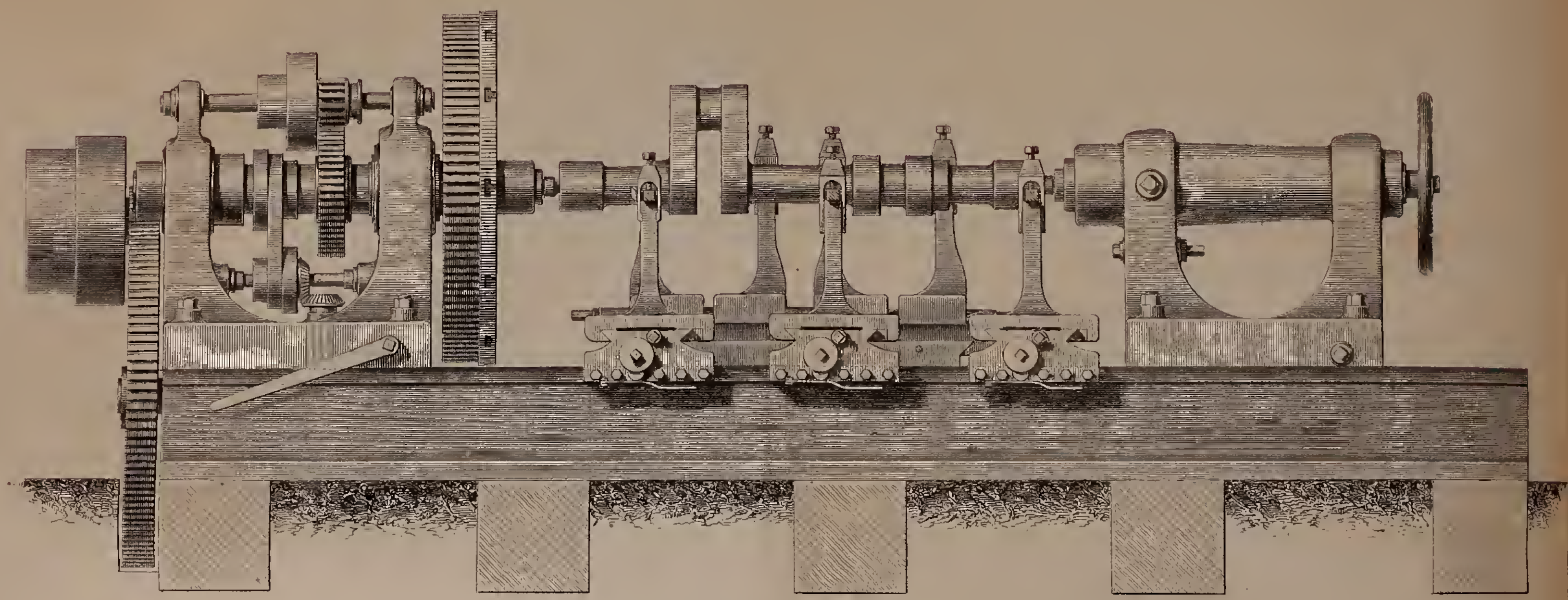


FIG. 1. SIDE ELEVATION.

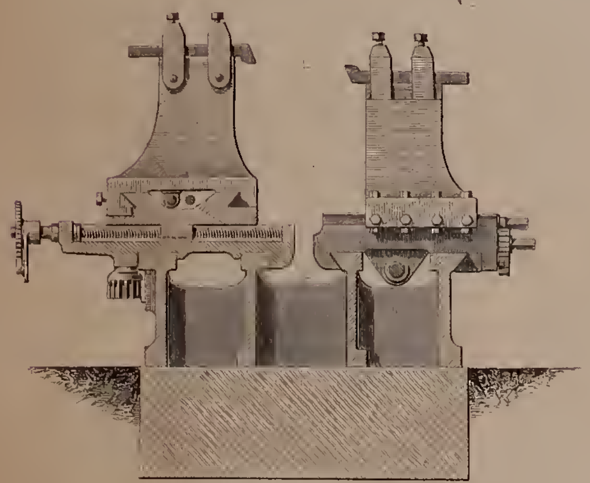


FIG. 4. SECTION AT A.B.

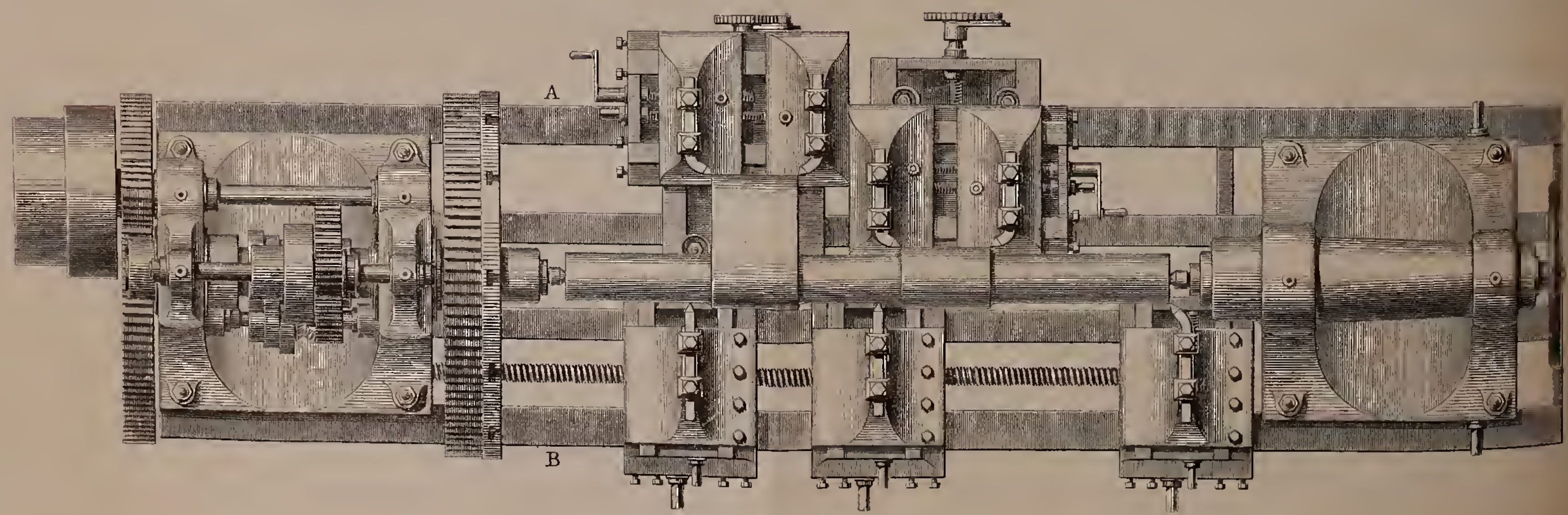


FIG. 2. PLAN.

W. Smith C.E. direx

CRANK CUTTING LATHE.

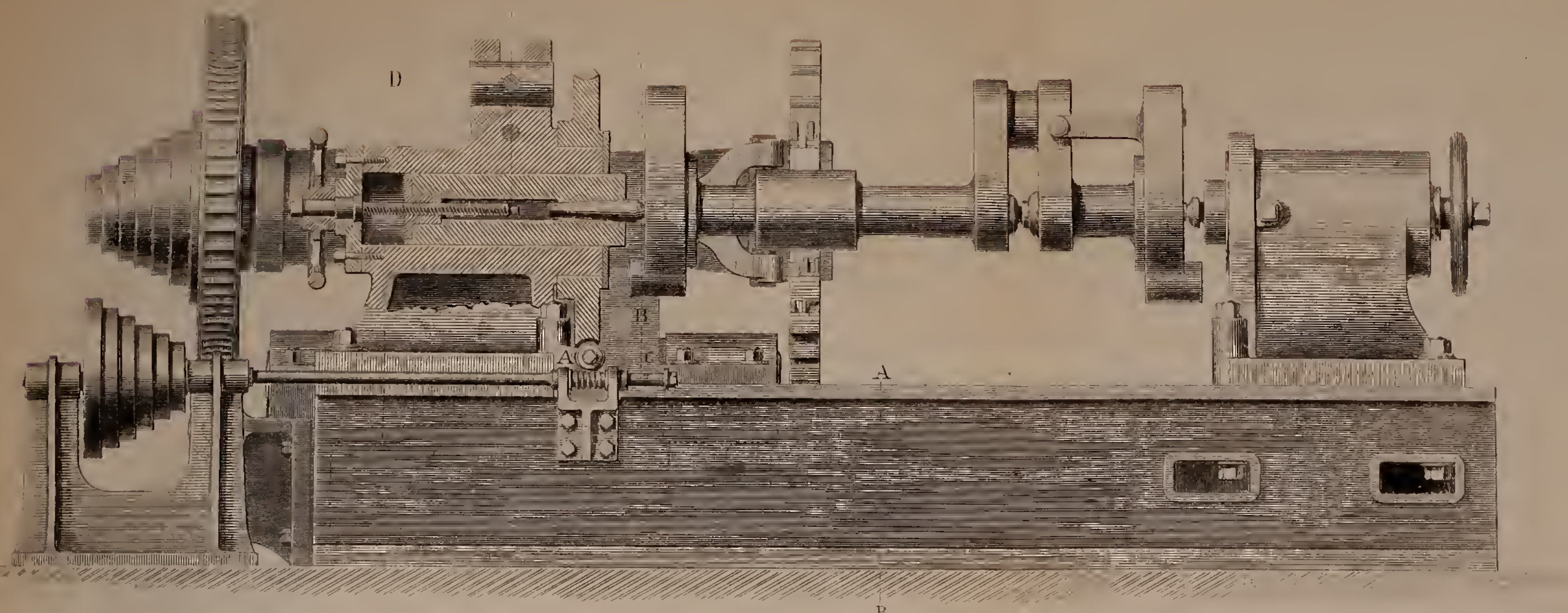


FIG. 1. ELEVATION.

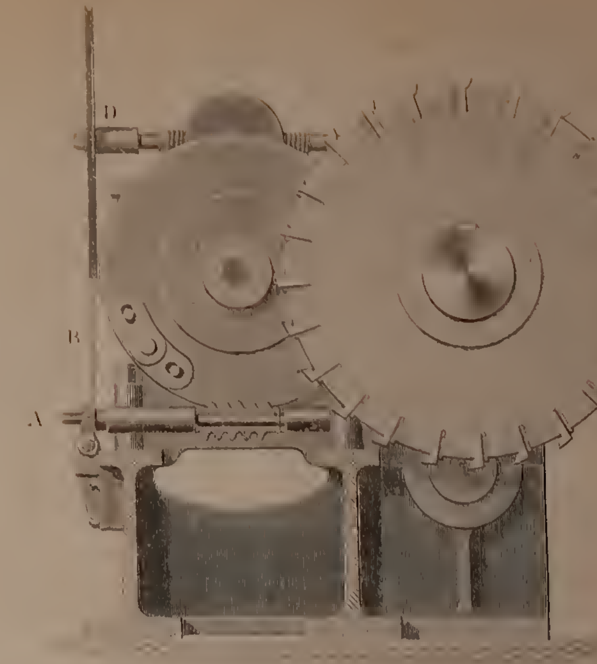


FIG 3. SECTION AT A B

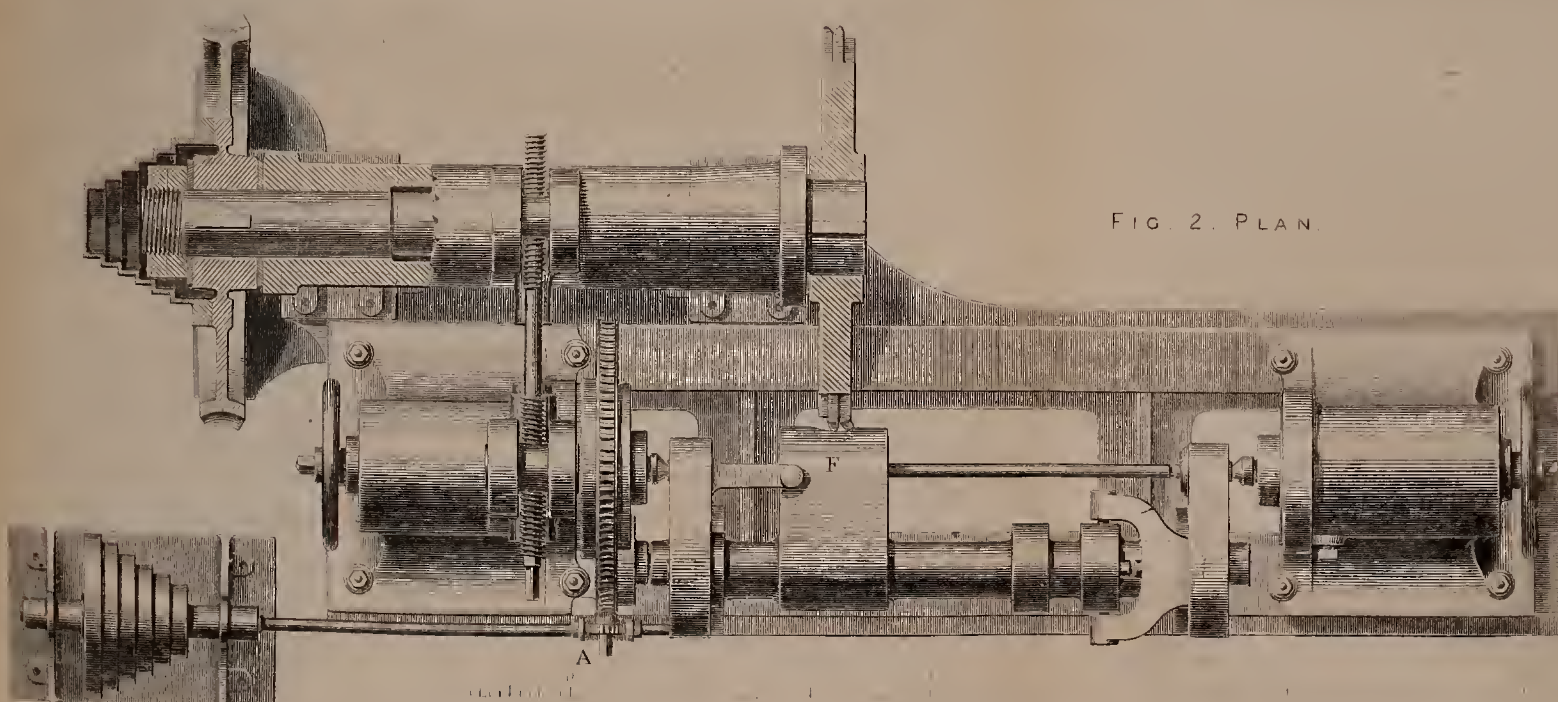


FIG. 2. PLAN.

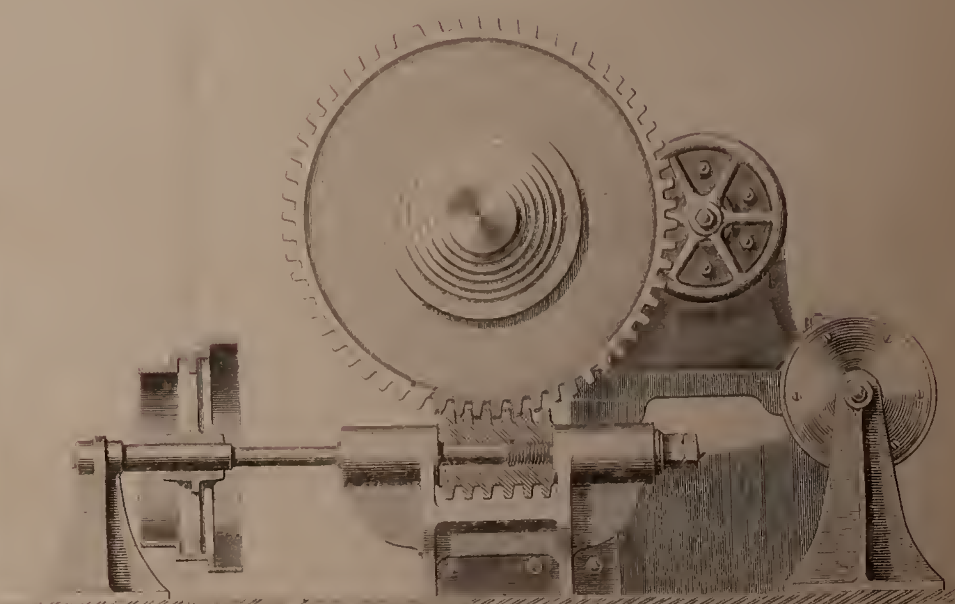


FIG 4. END ELEVATION.

W.S

THE ARTIZAN.

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APRIL 1st, 1866.

AN EXCURSION TO THE CREWE LOCOMOTIVE WORKS.

By J. J. Birckel.

(*Illustrated by Plates* 299 *and* 300.)

In our October number of last year (1865) we promised our readers a series of papers descriptive of certain special tools which we noticed on the occasion of a visit to the Crewe works last summer, but previous engagements have prevented us until now from fulfilling that promise; indeed, we then disturbed other arrangements in order to give an illustration of Mr. Webb's curvilinear slotting machine, because that tool appeared to us so novel and full of interest as to deserve precedence amongst other subjects for publication. We now proceed with that series by giving a description of a tool for the manufacture of locomotive crank axles, which, though not designed by the engineering authorities of the Crewe works, is highly appreciated by them namely, Sharp, Stewart, and Co.'s 7-tool crank axle lathe, illustrated in the accompanying plate, No. 299, and as the problem of turning and finishing axles forms a natural sequel to the subject treated of in the introductory portion of this paper, we here proceed to give a description of this lathe:—

It consists principally of a bed with four longitudinal ribs, having suitable faces for the reception of five saddles for the 7-tool rests, and of fast and loose headstocks. The loose headstock may be moved backwards, and forwards by means of a pinion working into a horizontal rack, and its construction in other respects is similar to that of the loose headstocks of any ordinary lathe. The construction of the fast headstock is similar to that of a wheel turning lathe, namely, the spindle is driven by a pinion working into a toothed rim cast on the circumference of the face plate, motion being received in the usual manner through a spur wheel, pinion, and cone pulley from a strap; for finishing and polishing, however, this motion would be too slow, and for these purposes a quicker speed is obtained through the small cone pulley at the top of the headstock, by the medium of a pinion and spur wheel, the face plate pinion being then, of course, thrown out of gear. Three tools, each having its own rest and saddle, are placed on the front side of the lathe, and are intended for sliding the body of the axle and turning the journals and the wheel seats. These sliding tools are worked by a screw with rounded thread, which is driven by a strap from the lathe spindle, and through a double set of bevil gearing; each saddle, of course, may be moved backwards or forwards by hand by means of a worm pinion, which performs also the functions of a nut. The four tools at the back of the lathe are intended for turning the outside faces of the crank sweeps; and rest by pairs upon two saddles, each of which may be moved longitudinally upon the lathe bed by means of a vertical pinion gearing into a rack bolted against the side of the lathe bed; each saddle is provided with a cross slide, upon which each tool rest individually and separately may be moved lengthwise to the axle, and the cross slides are provided with self acting feed gear.

In the accompanying plate, fig. 1 is a front elevation; fig. 2, a plan; fig. 3, an end view, and fig. 4, a cross section.

The first of these lathes was constructed in the years '56 and '57 upon the suggestion, we believe, of the late Mr. Forsyth, then shop manager at the Atlas works, and the anticipations of its probable useful results have, contrary to our own expectations, been fully realised. The men find no difficulty in working all the seven tools simultaneously, as we have had occasion to ascertain both at Crewe and at the Atlas works. Although it is so constructed that axles may be finished upon it, it is intended for roughing them out only when, owing to the great depth cut that can be taken, the most economical results are obtained from it.

On the occasions of our visits to the Crewe works, our attention was arrested also by a crank cutting lathe, of which we have produced a very detailed illustration upon Plate 300.*

The general practice up to now in dealing with locomotive crank axles when they come from the forge into the turning and shaping department has been to rough the body and journals out in the lathe, then to plane the flats of the crank sweeps to very near their finished size in thickness; when this operation was completed the axle was taken to the drilling machine, and three holes were drilled through the sweep at such a point as to leave stuff sufficient for giving a fair smooth face to the connecting rod journal in the neck of the crank; two cuts of about ½in. in width were then made into the sweep, under the slotting machine, care being taken to leave sufficient metal for giving a true finish to the inner faces of the crank sweep in the lathe. Under a powerful slotting machine the two cuts were taken out at one operation, and the slab of metal which remained between them, and which adhered to the neck of the crank by the two feathers left between the three adjacent holes drilled previously, was then broken off by driving wedges alternately into each of the cuts made under the slotting machine. The axle was then finished upon the lathe by turning alternately each crank sweep, and lastly the body and the journals.

The method just described of cutting out the sweep of the crank is attended with several serious evils. In the first place, some loss of time and consequent expense is incurred in shifting the axle from one machine to another; then a square lump of metal is left in the neck of the crank, making the operation of turning and finishing the connecting rod journal very tedious and proportionally expensive. More serious than these, however, is the evil which must inevitably result from the wedging process above mentioned, for the same strain which breaks the portions of metal left by the drill has to be resisted by those parts which afterwards have to perform useful and very severe duty, and while it is impossible to say to what extent injury is sustained by the metal in the neck of the crank, it is equally certain that the kind of fatigue to which it is subjected by that operation must have a positive injurious effect upon it. Prolonged experience, at any rate, shows that nearly all crank axles come to grief by breaking across the neck, and this fact alone should suffice to teach us that we ought to treat that weak part of the axle with the utmost care.

The machine which we are about to describe has been designed by Mr Ramsbottom with a view to obviating the various evils enumerated by cutting out the crank sweep and roughing out the neck with revolving cutters, while the axle is slowly turning round upon the axis of the crank pin. It consists chiefly of a bed plate fitted with fast and loose headstocks, each provided with a movable spindle, similar in every respect to the spindle of the loose headstock of an ordinary lathe, and the axle which has been previously roughed out upon the lathe in its body, journals, and wheel seats is fixed into the machine upon the axis of one of its crank journals in the usual manner by means of centreing blocks or dogs, specially prepared for cranks of different throws. The cylindrical body of the fast headstock is made to project a

* This plate will appear in our next issue.

short distance beyond the vertical ribs which connect it with its foot, and this projection is turned for the purpose of receiving a wormwheel which runs loose upon it, and which communicates its revolving motion to the axle by means of a pin which fits easily into a hole provided in the centreing block or dog; the wormwheel is retained in its place hy a washer plate which is screwed to the body of the headstock, and it is driven hy a worm whose shaft receives motion through a small wheel from a second worm keyed upou a shaft which is driven by a strap running upon cone pullies, the one which gives motion heing screwed upon the driving wheel of the revolving cutters. In consequence of this arrangement the crank ceases to revolve as soon as the cutters cease to work; it will he observed also that the use of the cone pullies gives great facility to alter hy gradual degrees the angular velocity or speed of revolution of the axle, which hecomes necessary as soon as the cutters hegin to act upon the flat portions of the sweep; to this effect also these pullies are provided with a great number of speeds.

Tbe cutter wheel is keyed upon a stroug spindle, carried hy a movable frame which swings, pendulum like, upon turned gudgeons, cast solid with it, and which rest in hored brackets cast on to the lathe bed, and fitted with caps for facility of removal. The object of this mode of construction is to enahle the cutters to he moved clear of the crank sweep iu the rough, and then to be hrought back gradually to a position where they shall shape out the neck of the crank to the desired size, leaving just sufficient stuff for truing up and finishing in the common lathe; provision has been made for hringing the cutters into their final position by self-acting process in the following manner:—At the commencement of the operation tbe small intermediate wormwheel, marked A, through which the axle receives its revolving motion is taken off and the axle brought to a standstill; a cord B is then attached to the worm shaft or feed spindle C, and a transverse motion is communicated to the cutter wheel by winding the cord upon the worm shaft and turning round the cord pulley D and the feed screw E, which is double, having a left-handed thread at one end, and a right-handed thread at the other; the left-handed tbread engages into a uut fitted into a projecting jaw on the fixed headstock, and the right-handed thread engages into a nut fitted into a similar jaw on the frame which carries the cutter wheel; it thus acts like a donble-tbreaded screw, and moves hodily hackwards and forwards hy half the distance through which the cutter wheel would move if it were placed at the same distance from the centre of oscillation as the screw; a stop screw or spindle is also provided upon the fast headstock to prevent the cutters from heing drawn too close to the centre of the lathe spindle, and tbus spoiling an axle hy making the neck of the crank too small iu diameter.

The spindle which carries the cutter wheel is made conical in one of its bearings, and provided with nut and lock nut at its other extremity in accordance with the usual practice in the construction of lathe spindles; it is driven by a worm wheel through a worm whose shaft is set in motion hy a strap running upon a cone pulley. The driving worm is made of greater length than is usual, owing to the transverse motion of the wheel with the cntter frame, and as the distance through which it thus moves is very small, amounting to ahout 1⅝in. only, while it swings npon a radius of 2ft. in length, it may be practically assumed that this motion is rectilinear, and that the pitch lines of the worm and worm-wheel are not disturhed from their horizontal position of contact, although the vertical plane of contact has shifted.

Mr. Ramshottom makes most, if not all, his crank axles of Bessemer's steel now, and we are informed by Mr. Wehh, the shop manager of the Crewe works, that it takes about ten hours and a half to cut out one sweep of a steel crank of 12in. throw; we do not hesitate to say, tberefore, that this machine saves upwards of 20 per cent. in the labour and expense of finishing a crank axle as compared with that attendant on the usual method descrihed in our introductory remarks.

The cutters appear to stand very well, and on an average will cut out three sweeps hefore they require sharpening.

In our illustration, fig. 1, is a front elevation of tbe lathe, and a partial section through the spindle of the fast headstock; fig. 2 is a plan and part section through the cutter-wheel and the hearings of its spindle; fig. 3, a cross section in front of the fast headstock, and fig. 4, an end view and part section through the driving gear.

At the risk of being deemed over complimentary, we must say that in our opinion no tool could bc better designed to accomplish the special object in view, and its usefulness appears to us so palpable that it ought to find its way into every locomotive shop as soon as it becomes known to makers.

(*To be continued.*)

ON STEAM AS THE MOTIVE POWER IN EARTHQUAKES VOLCANOES, &c.

By R. A. Peacock, Jersey.

(*Extracts from an unpublished MS.*)

The following two paragraphs ought to have appeared as the concluding part of the note at p. 54 in the Artizan of last month:—

But it would appear to be very probable from the following extract from a very striking paper, "On the Spectra of some of the Heaveuly Bodies," by Professor W. A. Miller, V.P.R.S., and W. Huggins, F.R.A.S., tbat the earth really was a planetary nebula when in its primitive condition:—"The third and most remarkable part of this communication was that which referred to the spectra of nebulæ; and the observations in this field were stated to have been conducted solely by Mr. Huggins. The nebulæ examined were chiefly those denominated planetary nebulæ. It was scarcely expected that the extremely faint light of these bodies would be sufficient to produce any spectrum at all; nor would it have done so had their construction been that which "has been usually assigned to them. But to the surprise of the observer he beheld, not a continuous spectrum, such as that which proceeds from a solid body, interspersed with dark lines due to atmospheric absorption, hut a spectrum consisting of a few bright lines, *such as that which proceeds from an intensely heated gas.* It was, indeed, the smallness in number of these component lines that enabled any success to be obtained; and the result from three or four of these nebulæ revealed the fact that they were in each case *composed of glowing gas,* probably hydrogen and uitrogen, witbout any solid nucleus whatever. But what can be the origin of this higb temperature, siuce, upon the principle of tbe conservation of energy, some other form of motion must be destroyed in order to produce the luminosity? Tbe origin of the light of the heavenly bodies thus becomes more perplexing than ever, and seems to point to some law regarding which we are yet iu the dark.—"Britisb Association Report, 1864, Transactions of the Sections," p. 12.

Must we not, perforce, answer this question by other questions? Supposing (as Mr. Huggins and the present writer agree) that a primary condition of the earth was, that it consisted of vapour, gases, nebulous matter, higbly heated. Must we not be content with that coudition as the most rudimentary to which human intellect can reach? How can hydrogen and nitrogen bc analysed so as to resolve them into still more primitive elements? Man's researches must from the very necessity of the case stop short of tbe very beginning. Have we any cboice except to suppose that it was in the vaporous, highly heated condition, stated in the hypothesis last month, that our earth was first projected into space as a planetary nebula, direct from tbe hands of the Creator? This conclusion however is intended to be *provisional* only. And it will not in point of fact, and of course it is not intended to impede, much less to stop, the progress of scientific investigation ou the part of those wbo may happen to think that the ultimatum of possible human knowledge, in this direction, has not yet been reached.

Works are erecting at Golden City, Colorado, for the manufacture of railway bars. Extensive mines of iron ore have been discovered there which promise to yield great wealth to the new State.

ELEVEN REASONS WHY THERE MUST BE CAVITIES IN THE CRUST OF THE EARTH.

By R. A. PEACOCK, Jersey.

(*From an unpublished M.S.*)

1.

The well known aperature on the shore of Cephalonia into which the sea has been running for ages (see *Evidence* No. 24), seems to give incontestable proof that there is a cavity beneath, and that it must be a large one, if we suppose with Sir Charles Lyell, that the water is converted into steam and escapes upwards. In which case the nearest known vents, Etna, and the Lipari Isles being each 300 miles distant from Cephalonia, that distance must be the length of the cavity. If Vesuvius is the vent, the length will be 360 miles. Of course the *breadth* and *depth* of the passage may be either great or small, we do not know. Or otherwise it must also be a large one, for if the water does not escape as steam, the cavity must be so vast that even *ages* of constant flow of water have not sufficed to fill it. Such an idea as this latter cannot be entertained.

2.

Marine fossils have been found at an elevation of more than 8,000ft. in the Pyrenees, 10,000ft in the Alps, 13,000ft. in the Andes. Captain R. J. Strachey found oolitic fossils 18,400ft. high in the Himalayas.[*] And the late Professor Forbes says that Illampu or Sorata (Andes) 24,812ft. high, is fossiliferous up to its summit.[†] When these were elevated must not large cavities have been left behind? And the like with other fossiliferous, and with all igneous ranges? Unless collapses took place about the bases of all mountains and ranges of hills, which we have no reason to believe. Lava, which is at most semi-fluid, could only partly fill the cavity, and even then it must have formed more cavity at the places from whence it had flowed.

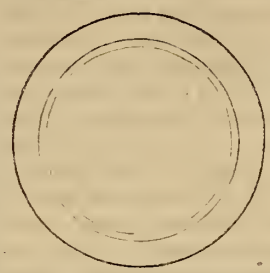
3.

We have seen in *Evidence* No. 3, in the February number of the ARTIZAN, that there must be a communication underground nearly 200 miles long between Skaptár Jokul and Nyöe. And in *Evidence* No. 58, that there must be underground communication between the volcano of Pasto and the volcanoes of Quito which are sixty-five leagues distant.

4.

We saw at the commencement of the paper for February that a force of $237\frac{1}{2}$ tons per square inch would be required to propel a column of granite 9ft. thick, to a vertical height of four miles. This was on the supposition, however, that it was *entirely unconnected with the adjoining ground,* and not impeded either by the friction of contact with the adjoining ground. Now, to propel a column 9ft. thick through a height of four miles, is equal to propelling a column four miles thick through a height of 9ft. The terms are convertible, the one into the other. And if we make allowance for *cohesion of the column to the adjoining ground,* we may scarcely affirm that a supposed force of 800 or 900 tons per square inch will do more than propel the mass of 9ft. thick through, say twice that distance, or eight miles of vertical height, so as to produce undulation. Mr. Mallett, C.E., F.R.S., states that the focus of the great Neapolitan earthquake of 1857, is 5·64 geographical miles, which however he conceives to be somewhat below the true depth, as a closer examination of the various wave paths led him to conclude that the probable vertical depth of the focal cavity itself does not exceed three geographical miles.[‡] We may, at all events, be pretty sure that so far as evidence has yet been gathered, either from the distances to which masses of rock have been hurled, or from dislocations observed by geologists in the Alps and elsewhere; that the maximum force can hardly be supposed to exceed 800 or 900 tons per square inch, and that it would scarcely do more after allowing for the uncertain amounts of cohesion and friction, than project a mass eight miles thick through a space of 9ft. Now to apply these considerations.

The average diameter of the earth, omitting fractions of a mile, is 7,912 miles[*] and the outside circle of the annexed figure represents that diameter on a scale of 1,000 miles to $\frac{1}{3}$in., and the thickness of the line forming the outer circle is ten miles, or $\frac{1}{300}$in., as nearly as may be. The two interior circles are respectively at 800 and 1,000 miles below the surface of the earth, on the same scale; and one or other of them defines the thickness of the crust according to Mr. Hopkins' calculations based on precession and nutation. Now it is clear, on a mere inspection of the figure, that earthquake shocks taking place at foci within the thickness of the line forming the outside circle, which represents ten miles by the scale; could not cause the undulations which are so frequently the accompaniments of earthquakes, *if the crust were solid,* and 800 or 1,000 miles thick. The mass of the crust would have too great a rigidity to be capable of being made to undulate, by a force acting within the thickness of the exterior line. We *must* suppose, therefore, that there are cavities (some filled with melted lava, and others with vapour, perhaps), else the undulations could not take place. For the force could at the utmost, only take effect, say, ten miles upwards and ten miles downwards, leaving hundreds of miles of solid crust below, quite unaffected; and consequently the whole solid mass of 800 or 1,000 miles thick would be unmoved and immoveable by a force so comparatively puny and insignificant as 800 or 900 tons per square inch. Undulations could not take place, even if the crust were a solid of only twenty-five geographical miles thick, as Humboldt supposed it to be. That is to say, it is immaterial to the present argument whether the thickness of the crust is twenty-five miles, or 800, or 1,000 miles, or something intermediate. Provided it abounds with cavities, and a sufficient number of them be filled with nothing more substantial than air, steam, or gases; the ground might then undulate in either case, as in point of fact it actually does.



5.

If the crust of the earth were a homogeneous solid, and if the interior nucleus were homogeneous also, the plumb line when freely suspended, would always hang in a direction pointing to the centre of the earth. As a matter of fact, however, it never does so point in the several instances about to be quoted, which are all I have been able to collect. Now this circumstance may mean either of two things, viz.: First, the crust may be cavernous or porous on that side from which the plummet is drawn away. Or second, the deficiency in attraction may be due only to material of less specific gravity. May we not fairly and reasonably conclude that the phenomenon is sometimes due to the first cause and sometimes to the second? Obviously, whether cavernous or only porous, either would hold steam; though of course the latter would not allow sinkings of ground.

195. *Instances of deflections of the plumb line.* It will be observed that deflection is the rule and not the exception, the line is *always* deflected more or less. M. Schweitzer, director of the Observatory at Moscow, found that a difference of 8″ in latitude existed between the result determined by direct observation, and that obtained by triangulation from distant well-known points. And by observations at very numerous stations in the neighbourhood, it was found that a line existed to the south of Moscow where observations of all kinds agreed; but that to the north there was a difference in one direction, and to the south in another. And that in the direction of the *meridian* the tract of country affected, seemed about *seventy-four miles* in extent, but that in the line of *east and west* the extent was greater, and had not yet been reached. The effect

[*] Lyell's Manual of Geology, p. 4.
[†] Quarterly Review, January, 1863.
[‡] "Great Neapolitan Earthquake of 1857," by Robert Mallet, Esq., C.E., F.R.S., 2 vols.

[*] "Herschell's Outlines of Astronomy," 1864, p. 139.

was that plumb lines at the two extremes converged $\frac{1}{50}$ part less than they ought, and the only explanation which could be given was, that a large trough of the earth was less in density than the surrounding country. There are no mountains, nor large surface of sea, to disturb the general effect of gravity, as those features were sometimes known to do.* Another account says that M. Schweitzer's more recent researches have confirmed the observations of the Russian geodesists, and established the existence of a local deviation to the extraordinary amount of 19 seconds within a very short distance of Moscow. At that city the plumb line deviates 8″ from the spheroidal perpendicular towards the north. At 20 versts (13 English miles) to the north of Moscow this deviation ceases. It ceases also at 12 versts (8 miles) to the south of Moscow; but on going further south, it recommences in a contrary direction, and at 25 versts (16 miles) to the south of the city, it is converted into a southern deviation of 11″, proceeding from Moscow in either an easterly or westerly direction, similar phenomena are observed. As there is nothing deserving the name of a mountain in the neighbourhood of Moscow, it follows as a necessary consequence from these facts :—

1st. That there exist beneath Moscow, enormous cavities; occupied by air, or perhaps by water (or as the present writer suggests, perhaps sometimes by steam, and at other times by steam and gases). Or,

2nd. That strata of some substance of very small specific gravity exist beneath the city. Or,

3rd. That there extends over the whole of the country surrounding Moscow, a generally loose, unconsolidated mass of geological formations (which would contain steam as well as cavities would) at a depth hopelessly beyond what human labour can ever expect to penetrate.†

197. *Deviations of the plumb line in India.* Archdeacon Pratt ‡ found by calculation that the deflexions were as follows at the three places named :—

	Kaliana. ″	Kalianpur. ″	Damargida. ″
In the meridian	27·853	11·968	6·909
In prime vertical	16·942	4·763	2·723
Total deflections	32·601	12·88	7·426 (p.94).

On these the Astronomer Royal of England, in another paper immediately following (p. 101), says "there is nothing surprising in Pratt's conclusion, it ought to have been anticipated, instead of expecting a positive effect of attraction of a large mountain mass upon a station at a considerable distance from it, we ought to be prepared to expect no effect whatever, or in some cases even a small negative effect. . . . Most physicists suppose, either that the interior of the earth is now fluid, or that it was fluid when the mountains took their present forms."

199. An arc of the meridian was triangulated a few years ago from Dunnosi in the Isle of Wight to Burleigh Moor in Yorkshire. And the deflexions of the plumb line at each extremity, and at three intermediate stations were noted. And it is remarkable that at not one of these five stations did the plumb line point, as prima facie it might have been expected to do, towards the centre of the earth. The deviations are as follows:—At Dunnose 1″·767 *south*, Greenwich, 1″·27 *north*, Arbury Hill, 1″·692 *north*, Clifton, 2″·864 *south*, and Burleigh Moor 3″.855 *south*.—*Paper* by Captain Clarke, R.E., Phil. Trans., R.S., 1858, p. 789.

The deflexion being towards the *south* instead of the north at Dunnose, is not a little remarkable. The low level of the sea and the less specific gravity of its water than so much earth, chalk, or rock, would naturally have suggested that the plumb line would have been deflected towards the *north*; in consequence of the large mass of the island and its considerably greater specific gravity than that of sea water. The sp. gr. of chalk is 2·781. Sea water only 1·028, distilled water being 1·000.

200. The deflexion of the plumb line at Arthur's seat is 5″·25, and at the Royal Observatory at Edinburgh, it amounts to 5″.63, both to the south. Phil. Trans., R.S., 1856, p. 591, by Col. James.

* Intellectual Observer, May, 1863, p. 305.
† "Cornhill Magazine," October, 1862, p. 550.
‡ Phil. Trans., R.S., 1855.

201. Early during the present century the headland eastward of Partsoy, on Cowhythe in Banffshire was visited by an officer of the Royal Engineers with the zenith sector, constructed for the Ordnance survey of this country by the celebrated Ramsden; and from the observations made with that instrument to determine the latitude of the trigonometrical station there, it was found that the plumb line, instead of being vertical was deflected northward of the zenith, and southward of the earth's centre, fully nine seconds of angular measure. By way of verification, a party of the same corps, some sixteen years back (1848), furnished with a new zenith sector, designed by the present Astronomer Royal, and constructed by Troughton and Simms, visited the same spot. More observations and to a greater number of stars, resulted in confirming the first or earlier determination.—Artizan, Nov., 1864, p. 259.

Cavities of various sizes, and positions, and at various depths, would perfectly account for all these deflexions of the plumb line.

6.

202. *Densities as observed by the pendulum.* In the Phil. Trans. R.S., for 1856, p. 42; The following table is given by Archdeacon Pratt, who takes it from Col. Sabine's volume on the pendulum. They are quoted as given. How can it be otherwise than that there are cavities?

Stations.	Excess or defect of Vibrations.	Scale of density of Strata beneath.
St. Thomas	+ 5.58	100
Ascension	+ 5·04	94
Spitzhergen	+ 3·50	79
Jamaica	+ 0·28	45
New York	0·00	43
Greenland	— ·08	43
Sierra Leone	— ·12	42
London	— ·28	41
Hammerfest	— ·52	37
Bahia	— 1·80	26
Drontheim	— 3·10	12
Trinidad	— 4.12	2
Maranham	— 4·34	1

These great variations are consistent enough with the deviations of the plumb line in various and opposite directions, and with the existence of cavities.

7

203. *The vast masses of materials ejected by volcanoes must have caused cavities beneath.* The volume of lava ejected by the Skaptár Jokul in Iceland, in 1783, was very immense. "Of the two branches, which flowed in nearly opposite directions, the greatest was fifty and the lesser forty miles in length. The extreme breadth which the Skaptár branch attained in the low countries, was from twelve to fifteen miles, that of the other about seven. The ordinary height of both currents was 100ft., but in narrow defiles it sometimes amounted to 600." And Sir Charles then mentions Professor Bischoff's calculations, which we have referred to before, that the mass of lava brought up from the subterranean regions by this single eruption, surpassed in magnitude the bulk of Mont Blanc.* This *must* have left a large cavity behind.

8.

206. In Bohn's translation of "Humboldt's Cosmos," vol. v., p. 170, 171, and notes; we read that cavities have been attributed to the elevation of enormous, sharp-edged, perfectly hardened rocks.

9.

Cavities must be caused by the solidifying and consequent contraction of melted stone. We learn from "Principles of Geology," p. 562-3, and a reference is there given to "Bulletin de la Soc. Géol.," 2nd series, vol. iv., p. 1312; that "according to the experiments of Deville and calculations of Bischoff, the contraction of granite when passing from a melted or plastic, to a solid and crystalline state, must be *more than ten per cent.*" which would certainly leave cavities.

* "Lyall's Principles of Geology," p. 427, who quotes Jameson's "Phil. Journ." vol. xxvi, p. 291.

10.

The aggregate subsidences or sinkings of land, must have been all along at least as great as the aggregate elevations, else the mean diameter of the earth would have been increased, and the day would have lengthened —unless the equator had revolved more rapidly, which we have no right to suppose.

Hear Sir John Herschell:—"The time occupied by one complete rotation of the earth on its axis, or the mean sidereal day, may be shewn on dynamical principles, to be subject to no variation from any external cause, and although its duration would be *shortened* by contraction in the dimensions of the globe itself, (and *vice versa* would be *lengthened* by increase of those dimensions), such as might arise from the gradual escape of its internal heat, and consequent refrigeration and sinking of the whole mass, yet theory on the one hand, has rendered it almost certain that this cause cannot have effected any perceptible amount of change during the history of the human race;* and on the other, the comparison of ancient and modern observations affords every corroboration to this conclusion. From such comparisons, Laplace has concluded that the sidereal day has not changed by so much as 1-100th of a second since the time of Hipparchus.†

When we refer to Lyell's "Principles of Astronomy," chap. xxvii., "On earthquakes and their effects," we find that the recorded sinkings are for the most part only from 2 to 10ft. in depth. Surely there must be a vast aggregate amount of sinkings yet undiscovered! And if so, must there not have been, and may there not be still, vast cavities?

II.

Some very extensive and deep sinkings have accordingly been discovered within a very short period (and doubtless more such discoveries are on the eve of being made). For example, "At a recent meeting of the Geological Society, a paper was read by Mr. Robert Dawson, relating to the occurrence of dead littoral shells in the bed of the German Ocean, *forty miles* from the coast of Aberdeen. From the fact of four species having been dredged in one day, Mr. Dawson considered that it was probable that they had lived and died where they were found, and did not owe their presence at that depth and distance from land to any mere accident."—*Illustrated London News*, March, 3, 1866, p. 219. Also from a private letter from an F.G.S. who was present at the discussion on Mr. Dawson's paper.

Again, it appears from a "further report on Shetland Dredgings," by J. Gwyn Jeffreys Esq., F.R.S. *Report of British Association* for 1864, p. 329. He says:—"More quasi-fossil shells were dredged, and for the first time in this district *Lepeta cœca*, dead, but apparently as fresh as any Scandinavian specimen. A perfect specimen of *Rhynconella psittacea* was also obtained at a depth of 86 fathoms; but it had two tell tale associates. One was *Pecten Islandicus*, and the other *Spirorbis granulatus*, var. *heterostropha*, of much larger size than specimens of the same Annelid from the southern coasts of England; the *Spirorbis* was also dead, and covered both the *Rhynconella* and *Pecten S. granulatus* has not been found in a living state north of the Hebrides, so far as I have been able to discover. This appears to have been one of the numerous relics of the glacial or post-glacial epoch, it is *an inhabitant of shallow water*, and affords another confirmatory proof of my hypothesis that *the Shetland sea-bed has sunk considerably during a comparatively recent period.*

But there is a still more surprising circumstance which remains to be stated. I quote from a private letter dated the 22nd ult., in which my correspondent says:—"We had a talk last evening (also at the Geological Society's) about the depression of land which had evidently taken place (but not in the historical period) between Malta and Jamaica." What the nature of the proof is, of this extraordinary depression, I cannot even conjecture. The Mid-Atlantic is too deep for dredging. But I have full confidence in the scientific knowledge and caution of my friendly correspondent.

Fourthly, it will be my business in future papers to endeavour to convince the reader that some two or three thousand square miles of land and sea-bottom, have sunk 100ft., and were within the last 1,900 years, on the westerly coasts of France.

For some or one of the eleven reasons just given also, there *may* have been; and for some or one of the same eleven reasons, there *must* have been cavities elsewhere.

* The hypothesis detailed last month, according to which the nucleus is of uniform temperature, accounts for the non-refrigeration and consequent non-shrinking of the bulk of the earth since Hipparchus' time.

† "Outlines of Astronomy," 1864, p. 667. NOTE.—Hipparchus flourished 2,000 years ago.

THE VENTILATION OF SEWERS.

It is with great satisfaction we learn that measures are now being taken to test the value of a system of sewer ventilation which appears to present prospects of a most encouraging character, Woolwich being the locality where the experiment is to be made.

The method to which we allude consists fundamentally in carrying off the effluvia of the sewage matter by means of the draught of a lofty shaft, and it is astonishing that so simple a contrivance should not hitherto have been adopted, proposed as it was by one of our correspondents as long back as 1847. At that period it was suggested to use towers or shafts to relieve the inhabitants of one of the largest towns in the north of England from the nuisance accruing from the foul gases evolved during the putrifaction of sewage, but the local authorities failed to perceive the merit of the plan, hence it was not then adopted, but has laid in abeyance since that period.

We may here pause to comment upon the peculiar short-sightedness of those who have undertaken to deal with questions relating to sewage during the last thirty years. Whilst schemes for deodorization,—many of which have been palpably absurd,—have occupied or rather monopolised the attention of sanitarians, the probably more important, because more easily practicable, point of sewer ventilation has been almost neglected.

It is true that if sewage matter is deodorised at the outlets of the channels through which it flows to its destination, the offence there is obviated, and the purity of the stream into which it flows remains intact, so that the putrescent matter which in such a stream would probably give rise to fever malaria, is rendered innocuous; but on the other hand, the deleterous gases generated in the sewers must be provided with means of egress in such a way that they shall not contaminate the circumambient atmosphere, otherwise a very great portion of the good results anticipated from fixing the malaria of the fœcal matter at the outlets of the sewers, would be nullified by a more direct and more general poisoning of the air of towns, by reason of the gases issuing into the streets where the inhabitants cannot avoid it.

The injurious nature of these emanations from sewers, even into our houses, could not fail to attract attention at once, or at all events even unscientific minds were willing to be convinced that they should be done away with because of the offensive stench indicating their presence, hence there arose a mania for trapping all kinds of outlets, not only in houses but in streets, and accordingly gullies were trapped, and the inventors of various kinds of traps reaped a rich harvest. In the next place it was found necessary to provide outlets for the gases thus caged in, in order that the sewers might operate properly from these two ideas, each acted on separately, there has arisen one of the most monstrous absurdities conceivable. We find in the streets of the metropolis, sewers with the gullies trapped at the *sides* of the road, whilst there are open ventilators in the *centre* of the road! The result, of course, of such a mode of procedure is just equivalent to having done nothing at all,—or at least would be but for the expense of making the two sets of work to counteract each other.

The only presumptive benefit to be derived from this system is that the effluvia issuing from the sewers may be less offensive to foot passengers when discharged into the centre of the road than when emitted at the

sides, but in the most important—the sanitary point of view—nothing can be gained.

The importance of having pure air is, if possible, greater than that of having pure water, for the atmosphere is *constantly* being inspired and respired, and upon that do we depend for the revivification of the blood, so as to keep it in a fit state to supply the growth and repair the wear of our entire human system; aud if the air drawn into the lungs contains any poisonous matter, such matter acts directly upon the blood, whereas the fœcal impurities of water are liable to elimination by the process of digestion.

The system of sewer ventilation to which our attention is now called consists in drawing off the noxious gases by means of a lofty tower or chimney; and if this mode be adopted in its most complete form, not only will the gases be removed, but they may also be to a great extent rendered inocuous.

If the ventilating shaft be furnished at the bottom with a small furnace through which the gases are drawn by such process, their noxious qualities will be destroyed.

In the construction of new streets, if the various flues in certain blocks of houses, instead of being terminated in separate chimneys, were all of them brought together in one shaft, and that shaft used to ventilate the sewers, then would the noxious malaria be partially or wholly deodorised by the particles of carbon evolved from the various fires, the flues from which are in connection with the ventilating shaft.

This mode of building could scarcely increase the expenditure, and it would certainly afford greater facilities for ornamentation than can be obtained when the ordinay chimney stacks are used.

ON THE CRYSTALLINE NATURE OF GLASS.

By Charles M. Wetherill, Ph.D., M.D.*

[From the "American Journal of Science and Arts."]

The usual explauation given for the different appearance of etchings by hydrofluoric acid in the gaseous and in the liquid state, is that by employing gas, the products of decomposition of the glass remain in the corroded cavities communicating a ground-glass appearance. This does not obtain by the use of the liquid acid, since in this case the said products are removed from the cavities.

An examiuation of this subject by the aid of the microscope at once showed that the ordinary explauation is erroneous. Ground glass is seen, under the microscope, to be covered with irregular cavities of uniform size, which act by the dispersion of light to produce the characteristic appearance of glass in this condition.

When glass is exposed to the vapour of hydrofluoric acid, the corrodent is deposited in the condition of minute globules, each of which attacks the surface to which it is attached. Articles of glass placed near the apparatus in which the gas is generated are thus coated with a delicate film of the vapour, aud are etched, so that the microscope exhibits extremely minute and shallow cavities in which, after cleansing the surface by water, no trace of other substance than glass is perceptible. When the exposure to the acid fumes is more prolonged, the cavities are deeper and more irregular. A still greater irregularity is effected by a more lengthened action of the corrosive vapour; the acid acts more intensely upon the spots first attacked, and the holes are extended with ragged margins and deepened by the action.

On the other hand, when the glass is immersed in liquid hydrofluoric acid, or if a drop of the same be suffered to fall upon the plate, the whole surface is corroded with a certain degree of uniformity. There are no minute points of action, as in the case of the deposition of spherules of the acid vapour.

Hydrofluoric acid gas, so called, is thus shown to be a vapour, constituted of minute drops, like cloud. It would be interesting to test the effect upou glass of the perfectly anhydrous gas obtained lately. From these considerations, hydrofluoric gas appears to possess in an eminent degree the cloud-forming property of antozoue. An appreciable quantity of this substance exists in the Woelsendorf fluor spar, and it may be questioned whether all specimens of this mineral do not contain traces of antozone.

In observing the specimens etched by the liquid acid, the crystalline nature of glass was discovered and witnessed in every case. By an examiuation of the literature of the subject it was ascertained that Leydolt (Wiener Acad. Bericht, viii., 261) had made this interesting and important discovery. I have been inclined to publish my results because Leydolt's observations do not appear to have received the attention which they merit; because my manner of applying the acid is different; and because crystals were observed of form differiug from those described in Leydolt's paper.

In addition to these reasons, his discovery may appear to need a certain confirmation, since Daubrée has asserted (Comptes Rend., xlv., 792) that the crystalline phenomena are due not to the glass, but to the deposition of crystals of fluosilicid of potassium, &c., which retard the corrosive action by protecting the glass under them. In the following experiments with as prolonged a microscopic observation as the object-glass could be trusted to the corrosive fumes, the result of the reaction of a drop of the acid upon the glass appeared to be amorphous. In an experiment in which a watch glass was exposed, with the convex surface downward, as a cover to a platinum crucible containing hydrofluoric acid, a lapse of twelve hours effected a deep corrosion. This was most extensive at the lowest point of the glass where a large drop of liquid was adhering. The solid products of the reaction had settled to the inferior portion of the drop, and some of them had fallen with previous drops into the crucible. A microscopic examination of the glass demoustrated the prescence of etched crystals, which could not, under the circumstauces, have resulted from a protecting effect of crystals of fluosilicid.

Frankenheim (Jr. pr. Ch., liv., 430) maintains that solid bodies generated from a liquid are always crystalline, although the crystals may be too miuute to be perceptible by our present instruments. His arguments, in the cases of glass, resins, and the like, are *a priori*, being based upon the analogies proceediug from a study of the general properties of matter. They render the crystalline character of glass very probable.

This chemist places the glasses, resins, aud fats iu the same category in their relations to crystallisation. In the transition of these bodies to liquids by an elevation of temperature, they pass through conditions of softness and semi-fluidity before melting. This softeniug does not depeud upon a malleability, as in the case of metals. Glass, for example, remains perfectly brittle to a certain temdcrature, and when fusion begins to take place the angles are rounded by the cohesion of the liquid portions and the adhesion of these to the parts uot yet melted. At a higher temperature, the liquid psrtion constitutes the mass of the body, but in it are suspended iunumerable solid particles, which communicate to it a sticky or gelatinous character.

When melted glass cools, its fusible compounds separate at first, and when the refrigeration is gradual a distinct crystallisatiou takes place. By a rapid cooliug the crystals must be more numerous and much smaller. If they cannot be detected in such glass by the eye or by aid of the microscope, the reason may be in their extreme teuuity, so that the light behaves to them as to the natural roughness of the polished surface. The author observes that silica is often separated in so fine a conditiou that it passes through the small pores of the filter. He finds no reasou in the phenomena of this class of bodies for an actual amorphism; but assumes that they are composed of crystals, which, although really small, are large in relation to the atomic molecules of the bodies.

He concludes (op. cit., p. 476) that "amorphous bodies, in the ordinary seuse of the expression, are unknown among solids, for solidity depends upon crystallisation."

Gaudin, in his *brochure (Reforme de la Chemie Minerale et Organique*, Paris, 1863), endeavours to show what crystalliue forms are probable for all bodies, deducing his results from the number of atoms in their chemical formulæ and the simplest manner in which they may be arranged. Chemists are divided as to the reliance to be placed upon Gaudin's views; but if they are tenable, or if in any degree fouuded upon reasonable grounds, the crystalline condition of all solid bodies would seem to be a uecessary consequence.

Pelouze (Comptes Rendus, xl., 1321), in an investigation of the devitrefication of glass, as in the so-called porcelain of Réaumur, exposed a tablet of plate glass to incipieut fusion upon the sole of a glass furnace for a period of 24-48 hours, and then suffered it to cool slowly. The result was a porcelain-like substance consisting of numerous opaque acicular crystals which were arrauged in parallel series, the individuals being perpendicular to the surface of the plate. It was found that the crystallisatiou proceeded from the surface to the interior of the tablet, and that when the process was arrested there was a distinct line of demarcation betweeu the crystalline and vitreous portion. In rare instances the fibrous structure was wauting, aud the crystallisation was of such nature that the fractured glass presented the appearance of fine white marble. Occasioually the crystals were replaced by au enamel-like material. In repeated experiments of this character Pelouze found that the glass experienced uo change of weight during the devitrefication, and the altered glass was restored to its transparency by a simple fusion. The process might be repeated several times without any alteration of weight. Devitrefied window glass, and more especially bottle glass when in large masses in the melting pots, sometimes exhibited yellowish-green needles, which were occasionally small aud short, but often exceeded a centimetre iu length, being closely adherent one to auother, aud interwoven in all directions. The vacant spaces between the crystals recalled the crystallisatiou of sulphur.

The crystallisation of the glass was assisted by the additiou of infusible or difficulty fusible substances to it when in the pasty condition. This is shown by the following experiment performed upou portions of material weighing one hundred kilograms.

Two melting pots were half filled with the same kind of glass, which was at first melted and theu suffered to cool uutil it had assumed a pasty or tenacious consistence. To one crucible a small quantity of vitreous matter was added, and both pots were suffered to cool. That to which nothing had been added contained a transpareut glassy mass, while the material iu the other crucible was nearly opaque from crystal aggregations. One per cent. of saud added to the pasty glass produced the same effect; and when quartz was employed the mineral retained its transparency, remaining mingled with the devitrefied mass.

Pelouze found that mirror, plate, lead, bottle, and bohemian glasses were all susceptible of devitreficatiou, although with different degrees of readiness, the tri-silicate of soda being the most ready. A glass of silica, boracic acid, potassa and zinc yielded merc traces of crystallisation; but the combinatiou of silica

* The observations of which an accouut is here given were made in the laboratory of the Smithsoniau Institute, Washington.

and boracic acid with potassa and lime could not be devitrified by an exposure of ninety-six honrs to a temperature at which softening took place.

This chemist infers that the change experienced by glass during this process is a physical, and not a chemical one. He states, as the result of many analyses performed by himself, that the crystals do not differ in compositiou from the vitreous mass in which they are embedded.

Dumas (op. cit.) takes exceptions to some of Pelouze's inferences, having found a difference in the constitution of the glassy and crystallised portions of the mass. Thus, in respect to silica; for the vitreous portion 64·7 per cent., and in the crystals 68·2.

Leblanc found in the two kinds respectively: for mirror glass 66·2 and 69·3; for bottle glass 57·9 and 62·95. In the bottle glass Leblanc found that the transparent portions contained 1·57 per cent. of protoxyd of irou, although only indistinct traces of this base were detected iu the opaque part.

Dumas therefore holds that the products obtained by Pelouzc are "analogous to mixtures of the fatty acids, which, by fusion, form a homogeneous liquid, which, by cooling, gives a fibrous solid, in which, although the eye can perceive nothing heterogeneous, each acid has separated iu its own crystal form."

Terreil (Comptes Rendus, xlv., 693) observed, in the melting pots of a glass furnace which had cooled very slowly, a perfectly crystallinc mass which contained cavities with small transparent crystals. These had a composition similar to that of a transparent bottle glass prepared from the same materials in the same proportions. Thus:—

	Glass crystals.	Bottle glass.
Silica,	55·85	56·84
Lime,	24·14	21·15
Magnesia	7·63	6·37
Alnmina,	2·22	3·64
Peroxyd iron,	1·06	2·59
Soda,	8·47	8·69
Potassa,	0·63	0·40
Mangancse,	traces	traces
	100·00	99·68
Spec. gravity,	2·824	2·724

For the composition of a partially devitrefied glass which was formed in the same furnace, under different circumstances, he found:—

	Vitreous part.	Devitrefied part.
Silica,	62·40	63·67
Lime	18·14	18·65
Magnesia,	4·47	6·12
Alnmina,	7·21	4·98
Peroxyd iron,	2·66	0·71
Alkalies,	5·12	5·87
Manganese,	traces	traces
	100·00	100·00
Ppec. gravity,	2·610	2·857

Leydolt (Wien. Acad. Bericht., viii., 261) introduces his expcriments upon glass etching by observations of himself and others upon specimens of glass and slag, in which crystals are visible withont the aid of hydrofluoric acid.

Thus Prechtl melted a considerable quantity of feldspar with 1½ cwt. of glass, and cooled the mass in water. In the inside of the lump, where the refrigeration had been more gradual, were found numerous crystals of feldspar, with well defined angles and edges, one of the crystals having the volume of a cubic inch.

Among the specimens of glass with perceptible crystals illustrated by Leydolt are the following:—

1. Green flint glass, perfectly transparent, containing opaque grains, which are resolved by the microscope into well defined octahedra of one-half a line in diameter.

2. A glass flux, of emerald colour, containing many groups of four-sided prisms, of white tinge and pearly lustre.

3. A large mass of blackish green glass, with prismatic crystals singly and in aggregations, also fibrous crystals in globular tufts. The colour of the crystals is dirty yellow, passing into green; their luster pearly. They had a rhomboidal section, and were a line in length by one-tenth of a line in thickness.

4. A bluish green English glass, containing tufts of needles uniting to globules of one and a half lines in diameter.

5. A glass flux, of red and green colous, containing a large quautity of small four-sided prisms, solitary, aud in tufts. The prisms were transparent, and of the same colonr as the glass, so that they could only be distinguished by the different degree of their refraction and that of the matrix.

6. A vitreons iron slag, of bottle green colour, containing perfect cubes of whitish tinge and pearly luster; also feathery crystals.

7. Another specimen of iron ore slag, similar to the last; but in which the cnbes are larger, of nearly the colour of the glass, and more equally diffused through the mass.

In a similar slag the cubes were of olive green colour, and in another specimen the cnbes were sparse and accompanied by feathery crystals. To these may be added the observations of Splitgerber (Pogg. Ann., lxxvi, 566), that in a lead glass slag presented to Farapay by H. Rose, he found large and well defined six-sided tablets. In a glass prepared with 100 silica, 40 soda, and 10 carbonate of lime, which were perfectly fused and suffered to cool slowly for six hours, he discovered fine acicular crystals grouped star-wise, like flakes of suow. These floated iu quantity in the melted liquid, and disappeared when the temperature of the crucible was raised again.

Leydolt's experiments of etching were performed by placing slips of glass in a mixture of flour spar aud oil of vitriol; by exposing glass plates to an atmosphere of hydrofluoric acid vapour; or finally by employing a very dilute solution of this acid contained in leaden vessels.

The following are his results:

1. A thick tablet of fine colourless mirror platc glass, after exposure to the vapour, was covered with colourless rhomboidal crystals. They projected from the plate, wcrc perceptible to the touch, and plainly visible to the naked eye, from the contrast between their lustrous surfaces and the rough etched background.

He obtained similar forms by flour spar and oil of vitrol, aud also by the use of the dilute acid. He infers that they are not quartz, which does not dissolve in hydrofluoric acid, but that they are of similar nature to that of their matrix.

2. A flint glass of bluish colour, passing into violet, transparent, and apparently homogeucous, yielded crystals by carcful etching. Ordinary window glass gave similar crystals which were of the form of rectangular tablets.

3. A pure trausparent English glass (a salt cellar). various vessels of French and Bohemian ware, very thick glass stoppers, glass of various colours, such as white bluish or green, and differently tinted glass fluxes and plates, all yielded similar crystals.

4. Some of the dilute residue of the reaction of sulphuric acid upon flour spar having beeu left in a beaker glass, etched the same, with beautiful tufts of fibrous crystals, giving thc appearance of some specimens of agate.

Leydolt infers from his experiments that all glass consist of an amorphous mass coutaining a variable proportion of crystals, and consequently; that not only density and composition, but also the more or less uniform distribution of the coystals, and their nature have a marked influence upon the character and optical behaviour of the glass.

He deems the following questions to be of importance.

1. Upon what circumstances depends the formation of the crystals in relatiou to quantity?

2. What influenee have the crystals upou optic phcnomeua?

3. May not their presenee have an influence upon the doubly refracting character which glass acquires by heating aud sudden cooling; or by pressure?

4. What substances may be dissolved in melted glass and separated therefrom by slow cooling?

Daubrée (C. R., xlv, 792) obtained various crystals by exposing glass for weeks to the action of water and steam in sealed iron vessels, at a tempcrature of 400° C. The glass was converted into a wbite. swollen, kaolin-like substance, composed almost entirely of crystalline particlcs. He found many crystals of quartz, and also acicular forms of nearly the same composition as Wollastonite (53 p. c. silica, 46 lime; with traces of magnesia). The quantity of water equalled half the weight of the glass, and the action of the water was the same as that of the steam.

Daubrée does not believe that the crystals pre-existed iu the glass; but were formed by the actiou of the water. Although this is probablc, it may be questioned whether some of the crystals were not ready formed in the glass.

My own experiments were performed by dropping strong liquid hydroflnoric acid upon plates of glass, using one or succcssive drops, according to the degrec of etching desired. By this means the euergy of the acid is expended upon oue particular spot of the glass, and by taking more or less of the solvent, or by employiug it of greater or less strength, the reaction is completely under control.

The acid was generated iu the usual manner in a leaden retort with a condensing tube of the eame metal, cooled with a mixture of salt aud ice; the liquid acid was received iu a platinum crucible, also rcfrigerated.

The following are the results of the experiments:—

When thc vapour escapiug from the crucible was condensed upon plates of glass, a "ground glass" etching, with, in some instances, distinct traces of crystallisation, resulted.

Thc following is the actiou of thc liquid acid upon different kinds of glass:—

1. Greenish window glass, free from lead. One drop of the acid acted energetically, coating the glass with a whitc sediment. When washed, the spot was found to be deeply etched, and presented a rougheued although transpareut appearance. Under the microscope, with oblique, transmitted light, the surface was found to bc covered with a web of acicular crystals, crossing at all angles, and presenting exactly the appearauce of sublimed caffeine. The average length of thc needlcs was 0·08 of a millimetre, their thickness somewhat less thau 0·006 mm.

It was difficult at first to determine whether the crystals were elevated, or depressed below the surface of the platc, in which case they would have represented casts of crystals dissolved out by the acid; but by careful managemeut of the light, studying the shadows and comparing them with caffeine crystals, they were judged to be in relief. Polarised light had no effect upou them. Beside these crystals, there were observed scattered over the field of view a few irregular etchings, in intaglio, which seemed to bc casts of crystalline scales dissolved out by the hydrofluoric acid.

2. A piece of the same plate of glass was treated with successive drops of the acid upon the same spot, waiting to add a drop until the reaction of the former onc had ceased.

A dcep etching was thc result, aud the extensively corroded surface presented here and there a ground glass appearance. Acicular crystals were apparent, although not as well defined as in the former example.

Nos. 3, 4, and 5 were slips of the same glass etched by vapour. Of these, No. 3 was vcry slightly corroded; upon No. 4, and still more upon No. 5, the action was of grcater duration. In these examples the evidencc of acicular

crystallisation was apparent, as a shading upon the ground glass surface. Towards the edges of the etched spot the needles were as distinct as in example No. 1. Here a few well-defined prisms with oblique extremities and one or two very small rhombic tablets were observed.

No. 6. Mirror plate glass. This specimen was corroded by a drop of the acid with greater uniformity than the window glass, although the etching was not so deep. It required careful management of the light to detect the crystals which were observed here and there in the form of scales or tablets, apparently broken and very small. A few acicular crystals were also detected.

No. 7. Plate glass (microscope slide). This specimen, when etched, presented the same appearance as No. 6. Very small acicular crystals distributed sparsely over the field of view could be seen.

No. 8. Three specimens of thin glass covers for microscopic objects. The etching of these was very uniform. Numerous and extremely minute needle-shaped crystals, requiring a high power for their definition, were observed.

No. 9. Green bottle glass (two specimens). In these the crystallisation was different from that of the former examples. In some places the etching was granular, as if small and short crystals had been removed by the acid. In other places blade-shaped crystals were apparent; these had a tendency to unite in starlike groups, as in snow. Upon one portion of the plate a few small squares and triangles (insoluble in water) were seen.

No. 10. Two specimens of Bohemian glass combustion-tube etched upon the inside. These yielded a granular, very regular etching, and presented a very delicate ground glass appearance, which was resolved by the microscope into small crystalline tablets or scales, apparently fragments of crystals.

No. 11. Bohemian beaker glass; two specimens, of which one was attacked upon the outside, and the other upon the inner surface of the vessel. Small acicular crystals, resembling those of No. 1, but better defined, and a few squares, triangles, and trapezoids were detected.

No. 12. Lead glass tubing; two specimens, etched upon the inside. The action of the solvent was energetic. The etching was granular, with numerous short and minute needles, requiring a high power of the microscope for their definition.

No. 13. A portion of a soda glass flask etched upon the inside. This was corroded very readily, and yielded plenty of needles resembling in appearance those of No. 1.

No. 14. Lead glass; inside surface of a matrass. The action of the hydrofluoric acid upon this specimen was energetic. The crystals presented the appearance of confused broken tablets, with here and there a needle-shaped crystal.

The acid employed in the experiments gave no etching when dropped upon the different surfaces of a cleaar transparent quartz crystal.

No. 15. After having completed the preceding series of observations the object-glass of the microscope was protected from the action of the hydrofluoric acid by cementing upon it a plate of thin glass with Canada balsam. A large number of experiments were then made with slips cut from the same piece of window glass, similar to No. 1, with the object of ascertaining by the microscope whether the residue of the reaction was crystalline, and whether, if so, it could have any influence upon the etching to give an appearance of crystals having in reality no existence.

The acid employed was strong enough to hiss when water was added, and emitted copious fumes. Dropped upon the glass it spread, forming a thin circular cake or film of solid substance having a granular appearance.

By a close inspection small prisms or needles were visible here and there in this residue. They were not so numerous as the etched crystals perceptible when the glass was cleansed, and it was not certain that they were not shadows of the glass crystals. In some cases larger prisms could be seen near the edge of the disc; these might be removed by the needle point; but under them was fovnd no corresponding etched appearance of a crystal.

In one instance the slip of glass was coated with wax for the purpose of confining the acid to a small disc where the glass was laid bare. This gave beautiful crystals, similar to the other specimenc. When the plate was covered with a thin film of oil the crystalline etching resulted as in the former instances. When the acid was constantly stirred upon the plate with the platinum spoon employed for dropping it, the crystalline etching resulted as before.

No. 16. At length an etching was found which served as an *experimentum crucis* to the question of the protecting action of the residue. In this case the acid was slightly diluted, but still fumed in the air. The glass, after having been acted upon, contained circular white patches of a ground glass appearance. By the microscope these were resolved into groups of star-shaped crystals, which, in some cases, were indistinct from corrosion; in others they were plainly crystals. Their appearance was exactly similar to that of the snow-flake, viz., stars composed of needles, which were combined with smaller needles, forming feathery rays. In two places long needles of one-eighth of an inch in length were visible. Beside these, the acicular web of the former specimens covered the glass. These starry crystals were undoubtedly in *intaglio*. The depression could be distinctly felt with a needle when observing under the microscope, and fine powder of vermillion filled the rays. When first viewed, before the glass was cleansed perfectly, the corroded remains of the crystals could be removed from the depressions with a needle point.

Now while we can conceive that a crystel formed by the action of an acid, might adhere so closely to the glass as to retard the corrosive effect of the acid under it, it is impossible to see how such a crystal could eat away the glass beneath it and thus sink itself under the surface.

In some of the other specimens these starry groups were perceived; but in no case as distinctly as in this one. There happened here to be groups of crystals which were large and very favourably disposed for the etching process. The result of this series of experiment seemed to throw some doubt upon the "elevated" character of the acicular web of crystals; at least as much doubt as may arise from the difficulty of judging the question from the shadows. The former conclusion was reached by a comparison of the shadows with those of a web of crystals of sublimed caffeine which were known to be in relief. If in intaglio, their depression is too slight to be able to form a judgment by rubbing the etching with vermillion powder. But as the stars are known to be depressions, it may be that the scattered needles are of the same character.

In some examples, two rays of a star-shaped crystal were seen giving the form of a V, which in other cases was transformed into a triangle by an additional needle happening to lie at its base. The Δ-shaped crystals described upon a former page may be formed in this manner, although they were not so determined.

It results that the window glass examined contains crystals already formed, of which some are more soluble in hydrofluoric acid than their matrix, and perhaps others less soluble in the same reagent.

All of the specimens of glass submitted to the action of hydrofluoric acid yielded crystalline forms. Those of the window glass are similar in appearance to the crystals obtained by Pelouze by the slow cooling of the same kind of glass after it had been maintained for several hours at incipient fusion. Since in the experiment of this chemist no alteration of weight was observed, and the normal character of the glass was restored by simply melting, it is probable that the crystals are of the same nature in both instances. It would appear from some of my observations as if the crystals first formed during the refrigeration of the glass were subsequently broken by the operations of pressing, rolling, &c., to which the material had been subjected.

Doubtless additional interesting phenomena might be observed by a more extended study of different varieties of glass under different conditions by the use of this method.

An analogous action of certain solvents upon other supposed amorphous bodies, as the resins, &c., may demonstrate a crystalline character in them.

From a more extended study of this interesting subject, results the most important respecting the true nature of glass may be expected.

The effect of annealing may here find its true explanation.

If we were able to produce at will an interlacement of long fibrous transparent crystals, a glass of superior flexibility and strength might be obtained. It would also be interesting to ascertain what kind of crystals of different substances might be introduced into glass without destroying its valuable properties. If such, having the crystalline character of mica or asbestus, could be added, a valuable product might result.

Leydolt observed in a slag (see his No. 7) cubic crystals of nearly the same colour as the glass and visible to the eye. If we could ascertain the nature of the matrix (which may also be crystalline), possibly we might, by the laws of ismorphism, be able to colour the crystals at will, thus producing new and beautiful effects in articles of glass ware. In this connection Leblanc's observation of protoxyd of iron in the transparent portion and but traces of this base in the crystalline part of a specimen of glass, may be noted.

The detection of the crystalline nature of glass demonstrates that we are as yet unacquainted with the true character of this complex substance; but at the same time it indicates the path to be pursued for acquiring this desirable knowledge.

THE NATIONAL BOILER INSURANCE COMPANY (LIMITED).

(*Continued from page* 64.)

Boiler Fittings.

It is especially necessary to the safety of all boilers that the water gauges be carefully attended and frequently tested, but numerous instances of carelessness or neglect are reported.

Many glass gauges were met with where the handles of the taps were broken, and in other cases the taps were so leaky that the gauge could not be properly tested, others were so dirty, that the height of the water was scarcely distinguishable. Many instances of the consequence of neglect of the water gauges have been recorded.

In one case a two flued boiler was fitted with glass gauge, and a float gauge, but the former was not kept in order, and the float only was used. The result was, that both the furnace crowns were seriously injured through deficiency of water.

I do not consider ordinary float gauges sufficiently sensitive for use on internally fired boilers, and would strongly advise that where attached to those externally fired there should be two gauges to each boiler, as a check on each other.

Several cases have been reported, where the glass gauges were fixed so low that the furnace crown would be actually bare of water when several inches were visible in the glass. These were certainly proofs of gross carelessness or ignorance on the part of those who fitted up the boilers.

As an instance of the gross negligence which is occasionally displayed by boiler attendants, I mention the following:—An externally fired boiler, fitted with a "float whistle" gauge, was found with the water so low that it was out of the range of the float, which the inspector found was scotched fast to prevent its indicating the deficiency.

Many safety valves have been found defective from various causes, and I am sorry to remark, that despite all that has been written at various times on the subject, and the numerous disasters which have occurred through their abuse, many instances of overloading with irregular weights of various kinds, and other defects have been reported. In one instance, where the safety valve was loaded to 40lbs. per square inch, the pressure

gauge indicated but 26lbs. when the valve was blowing off. The safety valve had in consequence been overloaded with pieces of iron to blow off with the gauge, thus seriously increasing the pressure, and the mistake was not discovered until the gauge was checked with a correct indicator, which showed it 14lbs. per square inch below the actual pressure. Fortunately the boiler was amply strong for the pressure at which it was usually worked.

This case is proof of the necessity of attaching suitable indicator taps to the boilers, to enable the inspector to test the valves and gauges, at each periodical visit.

In another instance an ordinary lever safety valve, fitted to a small cylindrical boiler and nominally loaded to 30lbs. per square inch, was found fast through omission of testing. The boiler was fitted with Bourdon's pressure gauge, which indicated 50lbs. per square inch, although the valve was not blowing off. On raising the lever of the valve, the steam blew off with great force until it fell to the proper pressure. Ordinary lever safety valves may so easily be overloaded, that it is desirable that each boiler should have a dead weight valve externally, as a check on the lever valve.

The safety valves of some of the boilers proposed for insurance were found, on inspection, to be loaded to above double the proposed pressure; of which the owners were quite unaware, until the boilers were inspected by the officers of this company.

Compound safety valves, which discharge the steam when the water sinks below the proper level and also act as ordinary safety valves, are a useful fitting, especially when attached to single boilers.

The defects to which gauges are liable is exemplified in the remarks on safety valves. Some of the gauges noted, were found seriously inaccurate; in one instance, the gauge indicated 20lbs. below the actual load.

Great difference of opinion exists amongst boiler owners in reference to the usefulness of fusible plugs; but the distrust arises in most cases from the faulty construction of many of the plugs in use. No fusible plug, nor other boiler fitting, can ever dispense with the careful watchfulness of a well trained attendant; but so many mistakes arise, and consequent accidents occur to boilers unprovided with them, that I consider it advisable to attach good fusible plugs to the furnaces of all internally fired boilers.

Smith's fusible plug, the patent right of which is the property of this company, is highly esteemed by boiler owners, as is proved by the great and increasing demand.

Numerous instances have occurred where its prompt action has prevented injury, to one of which I may just refer, as an example, where a boiler (insured with this company) was saved by it from serious damage.

The boiler (which had two internal furnaces) was left in the evening with slow fires in the furnaces, the water being above the ordinary level, and the pressure of steam noted, about 25lbs. per square inch. On the following morning the boiler was found quite empty, but the plugs had melted out; the escaping steam damping the fires, had prevented any injury being sustained by the furnace tubes.

The great superiority of this plug has been fully sustained by the experience of the past year, and confirms the confidence placed in it by this company in making the reduction of 10 per cent. from the premium of insurance of those boilers to which it is attached.

Several cases have been met with where fusible plugs of various kinds were fixed in cylindrical externally-fired boilers, right at the bottom, over the furnace, where they were, of course, quite useless; thus displaying utter ignorance of their use and application, on the part of those who attached them.

Many boilers are unprovided with feed back pressure valves. These valves are not always necessary to single boilers, supplied by a feed pump placed near thereto; but they should never be omitted in boilers fed by the pressure of Town's mains, as several narrow escapes from accidents have come to my knowledge, where the pressure having been unexpectedly reduced or turned off, the water in the boiler was forced out by the steam pressure therein.

Where several boilers work in connection, these valves are requisite, otherwise the water may be forced from one to the other, by unequal or irregular firing. Where the water is delivered above the level of the furnace crowns by means of a horizontal perforated pipe, the danger from this cause is much reduced, but I would still advise their attachment.

Some boilers are fitted with feed regulating valves so arranged that the pressure from the pump acts on the top of the valve, which is regulated by a screw spindle attached thereto. Should the valve become detached from the spindle, no water could enter the boiler, and the latter would have to be stopped, and the steam let down before the valve could be repaired.

Many boilers are quite unprovided with blow-out apparatus. A number of internally fired boilers are reported as having nothing but an iron plug at the bottom for the purpose of emptying them. This plan is most objectionable, as the water soaks into the brick work at the bottom of the boiler, and leads to corrision of the plates, and also frequently backs into the flues; interfering with their proper cleaning, and preventing satisfactory inspection. Suitable rivetted beds should always be provided for the attachment of the elbow pipe to the bottom, and the pipe should be of such a length that the tap may be easy of access for use, cleaning, &c. Where the water contains much sediment, the use of good surface blow out apparatus is in most cases of great benefit.

Boiler Explosions.

No boiler insured with this company has exploded during the past year, but the occurrence of not less than 53 serious explosions in the United Kingdom alone, have come to my knowledge, by which 47 persons lost their lives, and 82 persons were seriously injured. Total 129.

The above number probably will not comprise all the explosions which have occurred, as there are no means of ascertaining their precise number. The minor accidents, such as partial collapse of furnace tubes, &c., many of them but a narrow escape from actual explosion, have, as usual, been very numerous, and could their numbers be ascertained, would probably amount to some thousands.

The following is a list of the explosions above referred to.

The Exploded Boilers were of the following Descriptions.

One or two flued internally fired, 14; locomotives, 11; cylindrical externally fired, 12; iron furnace boilers, 5; portable (locomotive type), 2; vertical internally fired, 2; marine, internally fired, 2; balloon or haystack, 2; other descriptions, 3; total 53.

The causes of those explosions of which particulars have been obtained are as follows:—Deficiency of water, 10; external corrision, 8; internal corrision, 2; internal grooving at seams, 4; insufficient staying or malconstruction, 4; weakness of flue tubes, 4; fracture through flaws in iron, 3; overpressure, 2; failure of seams over furnace (externally fired boilers), 2; defective fire box stays (locomotive), 1; weakness of manhole cover, 1; no particulars obtained, 12; total 53.

The serious increase in the number of explosions of locomotive boilers calls for special remark, and must impress those persons entrusted with their charge, with the necessity of providing in new boilers for more reliable and frequent internal inspection than is now practicable. The number of explosions recorded in 1865 is eleven, against six in 1864, two in 1863, and three in 1862. The number of explosions of these boilers in 1865 being equal to the whole of those recorded for the three preceding years.

The judicious application of the hydraulic test would probably have led to the detection of weakness in some of the boilers which have failed.

When applying this test, every part of the boiler should be exposed to view, and it should be carefully guaged and examined before, during, and after the test, so that any alterations of shape or other defects may be detected; and it is of the utmost importance that the pressure should be kept up for a considerable time, so that any defects which may exist, may have time to develop and become manifest, otherwise the test may prove worse than useless.

As an instance of the value of the hydraulic test, the following is worthy of record. A large one flued boiler was proposed for insurance with this company, which was in course of being generally overhauled and repaired and also enlarged by the addition of several feet to its length. The old flue tube was 3ft. diameter throughout, $\frac{3}{8}$ plates, the new part of tube was gradually enlarged to about 3ft. 4in., the total length being about 38ft. The proposed load on safety valve was 60lbs. per square inch. It was suggested to the owners to strengthen the tube by angle iron hoops or cross tubes, and their attention was directed to the fact that the calculated load (per Mr. Fairbairn's formula), under which such a flue might be expected to collapse was little over 80lbs. per square inch. It was also recommended to apply the hydraulic test after the alterations, &c., were completed. Unfortunately the tube was not strengthened as devised, and on the test being applied, the flue collapsed almost the entire length, when the pressure had reached about 83lbs. per square inch, thus illustrating most forcibly the correctness of the formula referred to, and the value of the hydraulic test; as, had the boiler been set to work, the flue would in all probability have failed with fearful result.

Four serious explosions are recorded which were due to radical weakness of the flue tubes, and are sad proof of the necessity of making such tubes amply strong, to resist the strain to which they are subjected.

Various plans of strengthening flue tubes are adopted by many first-class boiler makers, most of which should be too well known to need mention.

By judicious arrangement of T iron, or flanging of the plates at the ring seams, cross tubes, water pockets, &c., Flue tubes of comparatively thin plate, and of large diameter, may be made much stronger than the outer shell of the boiler.

Flue tubes originally constructed without strengthening seams, &c., may at small expense be rendered safe by the addition of cross tubes or angle iron hoops. The latter should have ferrules rivetted between the hoop and plate to allow circulation of the water. If cross tubes are used at that

part of the tube beyond the furnace, they are advantageous in promoting the circulation of the water, and at the same time increasing the heating surface of the boiler.

The occurrence of no less than ten explosions from "shortness of water," is remarkable, and is far above the average from this cause. Probably the greater number of these boilers would have been protected from injury had they been fitted with good fusible plugs. Alarm whistles acted on by floats are useful in some cases in directing attentiou to the deficiency of water, but require constant careful attcntion to keep them in free working order.

The explosions caused by external corrision were chiefly due to moisture in the brickwork seating of the boilers. In several cases the boilers were placed in low situations so that the water from the higher ground drained into the flues, keeping the plates continually damp, thereby inducing serious corrisiou and consequent explosion.

One of these explosions was due to original defective workmanship. The boiler, which was two-flued and internally-fired, having leaked badly from the first, at the seams and various parts of the shell, causing extensive corrosion of the plates, especially those in contact with the brick midfeather upon which the boiler was set, where for a length of nearly 20ft. they were reduced to an average of less than ⅛in. in thickness. The outer shell of the boiler was torn into numerous fragments, but the flue tubes (one of which was projected to a great distance) were not collapsed. The damage to adjacent buildiugs and machinery was most serious and extensive. One person was killed and two more injured by this explosion.

In another case it was endeavoured to ascribe the disaster to deficieucy of water, and thus throw the blame on the attendant (who was killed by the explosion), although the plates were reduced to an average thickness of less than ⅛in. for a length of about 20ft.

The proportion of explosions from the failure of the furnace seams of ordinary cylindrical boilers externally fired is below the average, but two cases being recorded, the greater number of the explosions of these boilers reported being due to external corrosion.

The ordinary egg-ended cylindrical externally-fired boilers are most extensively used throughout the country; and as these boilers are often a source of continual annoyance and danger, through the frequent failure of the seams over the surface, necessitating frequent and expensive repairs, the subjoined notes on their management will probably be found of service.

The simple form and apparently great strength of these boilers too frequently cause owners to place them in charge of men, who through their ignorance often cause most serious disasters. If the water used deposits much sediment, and no effective blow-out apparatus be used, frequent and thorough cleaning will be indispensable; the feed water should be admitted regularly and continuously; filling up to a high level and working down should never be permitted. It is of decided benefit to heat the feed water before it enters the boiler, and to distribute it inside the boiler by means of a horizontal perforated pipe placed near the surface of the water.

The fires should uever be allowed to burn low, but the production of steam should be regulated by the damper, which should be so arranged as to be easy of adjustment.

The dangerous practice of throwing wide open the furnace doors to reduce the pressure by cooling the boiler, cannot be too strongly condemned.

When boilers are stopped for internal cleaning, the external flue brickwork should *always* be cooled down as much as possible, by opening wide the damper, and allowing a current of cool air to pass through the flues for a considerable time before the water is run out of the boiler.

Many good boilers are seriously injured by neglect of this most necessary precaution.

Regularity of working, combined with careful cleaning of the interior of these boilers would prevent many accidents which occur, but a boiler of this class can never be worked with such confidence in its safety as a well-constructed internally-fired boiler.

Mr. Hiller states, in conclusion, with reference to the construction and setting of boilers, that the successful working of boilers depends so much on the details of construction and fitting up, that too much care cannot be exercised in refercuce thereto; and he confidently asserts that boiler owners generally would often be materially benefited were they to avail themselves of the assistance offered through the officers of this Company before ordering new boilers.

The numerous explosions which occur from external corrosion indicate the great care which is requisite in planning and setting of boilers of all kinds. If the boilers are to be fixed at a low level, means should be taken to effectually drain away all moistnre which might collect in aud about the external flues. Most internally-fired boilers are now set on two side walls, formed of fire bricks or blocks, and occasionally the boilers are sustained by cast iron cradles fixed in the centre flue. Some engineers still prefer the old mode of setting on a midfeather wall. Where a boiler of large diameter is set on a midfeather, the great weight of the boiler is liable to cause bulging inwards of the lower plates, and for this reason alonc the two side walls are preferable, as the weight is thus divided. Boilers set on side walls are not nearly so liable to suffer from external moisture as those set on a midfeather. And Mr. Hiller notes that cast iron plates are often placed next the boiler, on the top of the midfeather, and are useful in preventing the conduction of moisture by the brickwork.

INSTITUTION OF CIVIL ENGINEERS.

ON THE PRINCIPLES TO BE OBSERVED IN THE DESIGNING AND ARRANGEMENT OF TERMINAL AND OTHER RAILWAY STATIONS, REPAIRING SHOPS, ENGINE SHEDS, &c., WITH REFERENCE TO THE TRAFFIC AND THE ROLLING STOCK.

By Mr. W. Humber, Assoc. Inst. C.E.

In this paper the author proposed to supply, what he conceived to be a want iu the records of the institution, the details of the arrangements of some of the principal metropolitan and other railway stations, particularly of a class which might be called "terminal-intermediate," as being a combination of both kinds, such as that at New-street, Birmingham, as well as of goods yards, wharves and depôts, and locomotive and carriage sheds, manufactories and workshops, which, it was to be regretted, had not been dwelt upon in the comprehensive commnnication "On the Arrangement and Distribution of Railway Stations," by Mr. R. J. Hood, (M. Inst. C.E.) read at the Institution in the session 1857-8, published in the "Miuutes of Proceedings of the Inst. of C.E." vol. xvii., pp. 449-481. For this purpose the plans of the following existing stations, &c., were illustrated and described, as they were believed to embody the leading principles and requirements involved in the construction of such works:—the Victoria Station, Pimlico, for the London, Chatham aud Dover and Great Western Railways, as well as that for the London, Brighton and South Coast, and the Crystal Palace lines; the Euston, Birmingham, and Stafford Stations of the London and North Western Railway; the Newton Junction Station on the South Devon Railway; the goods station at King's Cross belonging to the Great Northern Railway; the workshops at Battersea, connected with the London, Chatham and Dover Railway; and the Railway Carriage and Waggon factory of Messrs. Brown, Marshall, and Co., at Birmingham.

The anthor considered, that at termiual, terminal-intermediate, and junction stations, the through and local traffic should be kept distinct; that excursion traffic should not be allowed to interfere with the regular booking offices, either for through or local trains; that the platforms for the through traffic at terminal and jnuction stations should be at least 30ft. wide, and for the local traffic, docks, with separate lines of rails, could, if desired, be taken out of the extreme ends of these platforms, as at King's Cross; that the iu and the out parcels offices should be at the ends of the platforms furthest from the passenger and carriage entrances, as at King's Cross and at Paddiugton; that the position of the left luggage aud cloak rooms at Paddington had been found to be convenient; that all closets, &c., shonld be well ventilated, and be designed to perform the maximum of work with the miniuum of water, closets being arranged to flush both on the opening aud the closing of the doors, and glazed basins being preferable to slate for urinals; and that lavatories should be provided at all terminal and junction stations, as at Perth, even if a small charge were made for their use, which was not however the case in the instance cited.

He thought that the carriage running and repairiug sheds should be adjacent to termiual, terminal-intermediate, and junction stations, to avoid 'dead' mileage, and that the best situation was possibly between the passenger and the goods stations. A siding under cover should also be provided for engines in steam, with facilities for coking and watering. The goods yard and sheds might be either attached to and form part of the passenger station, though distinct from it, or a preferable plan was to place it at a distance, inclosed within its own wall. Its position, with regard to the main line, should be such, that trains might be run direct into and out of the sheds, &c., without the trucks having to be uncoupled. There ought to be separate arrival and departure platforms, provided with appliauces for the rapid loadiug, unloading, and sortiug of goods. It was desirable that mineral and goods traffic should be kept distinct, that sorting sidings should be provided for both, the arrangements being in all cases made with a view to avoid, as far as possible, the necessity of shuuting with engines. At junction and terminal-intermediate stations, there should be two through lines in the centre, over which goods and mineral traffic might be worked; and all such stations should be on a level, with short descending gradients at each end, to assist in stopping and starting the trains. At small termiual stations it was convenient to have the goods shed close to the passenger station, and parallel to the line, that the trucks might be shunted into it.

The engine and runniug sheds should be devised to facilitate the ready admission and exit of engines, as well as for overhauling, cleansing, and the execution of repairs. The sheds shonld be lofty, well-ventilated, have plenty of light, and space for the passage of men between the walls and the engines. The engine pits shonld be paved and well drained, aud there ought to be similar pits outside the sheds for rongh and dirty work. A plentiful supply of water, with a good pressure, and accessible by means of hydrants, &c., was necessary for cleansing and washing out the engine boilers when over the pits in the sheds. Lifting shears and overhead traversers were deemed to be superior to jacks, and the waste heat from the coke furnaces was useful for drying the sand to fill the boxes of the locomotives, as well as for heating the sheds during the winter

months. The coke platforms and the water cranes should be at the sides of the line into or out of the sheds, so as to be accessible without shunting.

Three classes of establishments were needed on all important lines, first, that for the construction and renewal of locomotive and carriage stock; second, the running shops, where light repairs might be executed; and third, engine and carriage sheds for receiving the stock when not in use. The principal workshops should be situated where labour and materials could be most cheaply and easily obtained; and they should be so arranged as to avoid unnecessary handling and shifting of materials, the aim being to let the raw material enter at one end pass through its various stages, from one machine to another, until it came out in a finished state at the other end.

At the Victoria Stations, Pimlico, two principles were illustrated, the booking offices being parallel with the London, Chatham and Dover, and at right angles to the Brighton line. The former plan was useful for trains of great length, at distant intervals, though it became a question whether the arrival platforms did not then exceed the length of the longest trains. A long departure platform admitted of a second train standing behind one about to start, but without care this was liable to lead to confusion. Where the traffic was of a mixed character, with trains in quick succession, the end booking offices seemed to be the best, provided that there was sufficient width of frontage, to allow of the several booking offices being distinct, and opposite to their respective platforms. At the Euston Station, the booking offices were situated on each side of the large central hall, from which access was gained to two departure platforms one on either side. As the trains were started indiscriminately from both, it was submitted that this plan must lead to confusion. The great length of the platforms was a good feature, but the lowness of the roof was objectionable, and the frequent supporting columns necessitated many turn-tables. The London Bridge Station of the South Eastern was cited as an illustration of the way an immense traffic had been worked in an inconvenient position, and a restricted space, by combining to a certain extent, the three systems of having booking offices on the departure side, at the ends of the platforms, and in a fork between the lines; which alone, it was believed, had rendered it possible to accommodate the numerous trains for the main line, the North-Kent, the Mid Kent, and the Greenwich traffic.

The New-street Station at Birmingham was an intermediate one for the London and North-Western and the Midland railways, and a terminal one for the Stour Valley. There were two main lines through the centre of the station, and the platforms were approached by sidings, so that the through traffic need not be interrupted. The station was situated in a cutting between two tunnels, and was so close to one, that the points for parting the trains were within the mouth of the tunnel, leading frequently to delay. The roof was in one span, and a considerable height from the ground, securing ample ventilation. The Stafford Station, recently erected, was terminal for the Trent Valley and Shropshire Union trains, and intermediate for the London and North-Western. Here also there were two main centre lines, the platforms being likewise approached by sidings, while there were docks at each corner of the station for local or terminal traffic. The goods station was only a short distance from that for passengers, and there were sorting sidings for the goods, but only on one side of the line. Newton Junction on the South Devon Railway was approached by a single line at one end, and was provided with three platforms, two for the main line traffic and one for the Torquay and Dartmouth Branch. The carriage repairing shops, engine and running sheds, smithy, &c., and the goods warehouse had all been proved to be conveniently arranged.

The Goods Station of the Great Northern Railway at King's Cross, comprised goods warehouses, coals depôts and wharves, potato stores, engine shed, repairing sheds, stores, stables, and all the necessary offices for conducting the large goods and mineral traffic of that line. The Midland Railway had also a goods warehouse, and a circular running shed at one side of the station. The Great Northern goods shed was nearly in the centre of the yard, and there were fourteen lines of way running into it, with a platform on each side for the reception and dispatch of goods, space being reserved outside these, but still within the building, for the vans engaged in collecting and distributing the goods. The outer lines next the platforms were used, one, on the east side, for unloading the trucks with the inward goods, and the other, on the west side, for the loading of the outward goods. The inner lines nearest to these were used for the arrival goods trains, and for empty trucks and making up trains for departure. After the trucks were unloaded they were taken by means of a turn-table and through cross roads to the departure side, whence they were removed as required, were loaded, and dispatched. There were great facilities for the rapid dispatch of goods, both inwards and outwards. The goods were entirely under shelter, could be unloaded, loaded, and dispatched without the use of a locomotive in shunting, except at certain seasons when the traffic was very heavy. Hydraulic power was employed for working the cranes, and at all large stations it was found to be economical in every respect. The stables were under the platforms, by which a great saving of space was effected. The granary was at the south end of the goods shed, and was approached by two lines through the centre of that shed, two other lines, one on each side of the former, being reserved for full trucks. After being unloaded the empty trucks were removed by two lines, one on each outer side of the goods shed. There was a water communication between the granary and the goods shed and the Regent's Canal, so that lighters could receive or discharge their freights direct from or into these buildings. On the west side of the goods shed were the coals depôts and staiths, and a coal and stone dock also connected with the Regent's Canal. Adjoining there were numerous private wharves for bricks, &c. On the north were the engine, repairing, and carriage sheds. These were laid out on the radiating or fan-shaped system. There were eleven lines in the centre, at the extremity of the fan, in the repairing shed, with shops in the rear, seven lines on the south in the locomotive painting shed, and seven on the north in the carriage shops. The running shed was placed in the centre of the fan, in front of the repairing shed, with which it communicated by means of a through line, connected with the repairing shed by means of a traverser.

The locomotive workshops of the London, Chatham and Dover Railway, at Stewart's-lane, were conveniently arranged with a view to the saving of labour, but were not so extensive as those at Crewe, Wolverton, or Doncaster. A single line of rails connected the works at the entrance with the main line, by means of points and crossings. Two parallel lines of way, running east and west, were connected with the several buildings by turn-tables. Roads for spare trucks, &c., connected with the main line, were provided with a separate entrance. Adjoining were the repairing shops and a semi-circular running shed, struck with a radius of 150ft. Only the outside 50ft. were covered, and in this building there were twenty-one stalls for engines and tenders. The turn-table was not covered, nor the forty roads radiating from it, each of which was sufficient for an engine with its tender. It was connected with the main line by three separate lines. The disadvantage of this arrangement was, that should the turn-table get out of order, all the engines then in the shed would be penned up until the defect was remedied. At the back of the running shed was a repairing shop, with smithy, engine, and boiler house, &c.

The new shops of the London and South Western at Nine Elms, and the engine sheds of the Metropolitan at Bishop's-road, were supplied with traversers worked by steam power, by which a saving of space was effected. The employment of duplicate traversers, one for each end, to prevent delay in the event of an accident, would probably be ultimately adopted. Detailed particulars were given of the Britannia Carriage Works at Birmingham, belonging to Messrs. Brown, Marshall, and Co.; and it was stated that they were conveniently situated in regard to railway and canal accommodation, and to facilitate the economical and rapid manufacture of railway carriages, waggons, &c.

The relative merits of the three kinds of engine and running sheds, the rectangular, the circular, and the radial or fan-shaped, were then considered. The latter system required great space, but by placing the running shed in the centre, in front of the repairing shed, the area was utilized. Another disadvantage was that all the engines must pass over one pair of points; but this was not so objectionable as the single turn-table in the centre of the shed. To guard against delays from accidents, a few engines in steam should always be kept at the terminus. The accommodation afforded by the rectangular building in the centre of the fan was equal to that provided by the circular, while the area covered by the latter was nearly one-third more. The rectangular required a greater amount of permanent way, but the building was less costly. The only advantage the semi-circular possessed over the circular shed was that a portion of the radius only was covered, whilst a greater length of extra road was required between the turn-table and the shed.

THE HYDRAULIC LIFT GRAVING DOCK.

By Mr. EDWIN CLARK. M. Inst. C.E.

It was stated that this invention dated as far back as the year 1857. At that time the Victoria (London) Docks were just completed; and the engineer, Mr. Bidder, being anxious to adopt some cheaper system of docking large vessels, than by an ordinary graving dock, or any modifications of it, considered various schemes for floating docks. These were, however, all found to be more or less objectionable, from the difficulty of designing such large floating structures with sufficient rigidity to preserve their form under very variable strains, and of insuring that stability of flotation which was wanting in all floating docks then in use, as well as from their enormous cost. It then occurred to the author, who, under the direction of Mr. Robert Stephenson, had designed the machinery, and superintended the raising of the Britannia and Conway tubular bridges, that a similar process might with advantage be applied to the docking of a vessel. The problem was simply to raise a given weight to a moderate height in the most rapid and economical manner, and there appeared to be no reason why a vessel should not be dealt with in the same way as any other load. The weight actually lifted at the Britannia bridge, with only three presses, was equal to that of a vessel of 1,800 tons.

In noticing the early history of graving docks, it was remarked that the expedients at first adopted continued in use in their original form, the principles involved having in no way been departed from, so that a modern first-class graving dock only differed in its dimensions and details of construction. Allusion was next made to the dry docks at present in use, and the dimensions were given of a work of this kind recently completed at Portsmouth, which was sufficiently large for docking the *Minotaur*, a vessel of 6,621 tons. The inclined plane or slip, had also received its share of improvement. In situations where the foreshore was favourable, it was observed that the slipway was peculiarly applicable for small vessels, on account of its economy, and that the hydraulic press had been used advantageously as a hauling power. But a graving dock of large dimensions was necessarily a costly work. It must be approachable by a deep channel, and must therefore be adjacent to deep water. In a gravelly soil, or in rock penetrated by fissures, the difficulties were sometimes nearly insurmountable. Doubtless the great cost of these docks, and the impracticability of making them at all, in some situations, led to the use of floating docks. These were at first built of timber of moderate size; and a description was given of a work of this kind in the harbour of Marseilles. The same principles were subsequently applied to docks of large dimensions, constructed of wrought iron, and furnished with elaborate pumping machinery. This system attained considerable development in America, there being timber docks on this principle at New York, Charleston, Savannah, Mobile, New Orleans, Portsmouth, and Pensacola, a full description of which would be found in Mr. Stuart's "Naval Dry Docks of the United States." Those at Portsmouth and Pensacola were so arranged that, after a vessel was placed on the pontoon, it might be hauled ashore on its cradle, on bedways prepared for the purpose. The dimensions of

that at Pensacola, which was completed in 1851, with the cost, were given. The floating sectional docks at San Francisco and at Philadelphia were next described. It was contended that the use of floating docks was necessarily limited, not only by their enormous cost in construction and manipulation, but by their liability to accident from mismanagement, of which instances were cited.

It was with a view of meeting, as far as possible, the objections to existing systems, that the author proposed the Hydraulic Lift Graving Dock as an efficient and economical substitute for the requirements of the Victoria (London) Docks. The works were ultimately undertaken by "The Thames Graving Dock Company," the site selected being a plot of 26 acres of land lying between the Victoria Docks and the Thames, and below the level of high water. This site admitted of a direct entrance from the docks, with a permanent water level, without the cost and delay of a special entrance from the river. The soil was a deep bed of bog and alluvial mud, on a substratum of gravel. The only excavation necessary was the lift pin, and its deep entrance to the dock, where a coffer-dam was employed. The depth of water in the lift was 27ft.; over the remaining water space it was only 6ft., which was the maximum draft of the pontoons. In the shallow-water space there were eight pontoon berths, separated by jetties, for workshops and access. They were all 60ft. wide, and from 300ft. to 400ft. long. The area of shallow water was 16 acres, or sufficient for floating fifteen or twenty pontoons, which, it was estimated, was about the number that might be kept employed by a single lift. The docking of a vessel consisted of two distinct operations:—first, the direct raising of the weight on the lift; second, the transportation of the vessel to any convenient position for its repair on the pontoon. The lift was a direct mechanical appliance for raising the vessel by means of hydraulic presses. It consisted of two rows of cast-iron columns, each 5ft. in diameter, sunk about 12ft. in the ground. The clear space between the rows was 60ft., and the columns were 20ft. apart from centre to centre, and were placed on each side of the lift pit. There were sixteen columns in each row, giving a length of 310ft. to the dock; but, as vessels might overhang at the ends, there was a practical working length of 350ft. The columns were sunk in the usual manner, about three or four being fixed per week. When the requisite depth was attained, the base was filled with concrete, and covered with a layer of planks, to act as a cushion for the cast-iron seat on which the press rested. The columns supported no weight, but acted solely as guides for the cross-heads of the presses, which moved in slots, reaching from the top of the presses (just clear of high water) to the top of the columns. The column was covered by a cap, and each row was firmly connected together at the top by a wrought-iron framed platform, running from end to end of the dock on each side. This platform formed a convenient permanent scaffold for raising the rams. The whole length of a scaffold was 68ft. 6in. Each column enclosed a hydraulic press of 10in. in diameter, having a length of stroke of 25ft. The rams were solid, and each carried a boiler-plate cross-head 7ft. 6in. long, thus extending 1ft. 9in. beyond the column on each side. From the ends of the cross-head were suspended two iron girders each 65ft. long, extending across the dock to the corresponding column and press on the opposite side. There were thus sixteen pairs of suspended girders, forming a large wrought-iron platform or gridiron, which could be raised or lowered at pleasure, with a vessel upon it. The sectional area of each ram being 100 circular inches, a pressure of 2 tons per circular inch gave 200 tons as the lifting power of each press, or 6,400 tons for the whole lift; but to find the available lifting power, it was necessary to deduct 620 tons, being the weight of the rams, cross-heads, chains, and girders, leaving 5,780 tons for the pontoon and vessel. The water was forced into the presses immediately beneath the collars at the top, this being an accessible position. The grouping of the presses was an important consideration. Stability was secured by arranging them in three groups; one group of sixteen presses, occupying the upper part of the lift, the remaining eight presses on one side forming a second group, and the opposite eight constituting the third group. The presses in each group were all connected, so that perfect uniformity of pressure was secured in each group as regarded its individual presses; while the three groups were arranged so that their centres of action formed a tripod support, upon which the pontoon was seated. As any one point of the tripod might be raised or lowered, without regard to the other two, by the most simple manipulation, the pontoon could be either maintained perfectly level, or any inclination could be given to it that was desired. Any pair of presses might be instantly cut off in the valve room, by means of a plug, even during the operation of lifting, without interrupting the process. It was stated that the raising of a vessel occupied about twenty-five minutes; and that during the severest cold, a few occasional strokes of the engine were sufficient to keep all in motion, and prevent congelation.

This lift was all that was required for raising or docking a vessel, and it was believed that it would be found more economical and convenient than any ordinary dock; but it would accommodate only a single vessel, whereas, by the use of pontoons, an indefinite number of vessels might be placed afloat, whilst the most costly part of the system remained constantly available. The following was the arrangement adopted: An open pontoon, proportioned to the size of the vessel to be docked, was selected. Keel blocks and sliding bilge blocks adapted to the vessel formed part of the pontoon, which was placed on the cross girders, and sunk with them to the bottom of the dock. The vessel was then brought between the columns, and moored securely over the centre of the pontoon. By lifting the girders, the keel blocks were first brought to bear under the keel of the vessel. The side blocks were then hauled in, by chains laid for the purpose on each side of the dock, and the girders and the pontoon, with the vessel upon it, were then all raised by the presses clear of the water. The pontoon was provided with valves in the bottom, and thus emptied itself of water. The valves were closed, and the girders again lowered to the bottom, but the pontoon, with the vessel upon it, remained afloat. Thus, in about thirty minutes, a vessel drawing 18ft. of water was left afloat in a shallow pontoon drawing only 4ft. or 6ft., and might be taken into the shallow dock prepared for its reception. The details and dimensions of the seven pontoons at present in use were given. The cost of the lift complete and fixed, including columns, presses, girders, and pipes, had been £20,300; of the 50 H.P. condensing engine and pumps, &c., £3,600; and of the connecting pipes, &c., £1,628. At the end of last year one thousand and fifty-five vessels had been lifted, of an aggregate tonnage of 712,380 tons, without a single casualty.

The advantages of the pontoon were then discussed, and certain proposed modifications of the system showed the practicability of enlarging it to meet the requirements of vessels of any size, were described.

In conclusion the author considered the principal features of the system were its economy of first cost, by the short time required for its construction and erection, and its subsequent maintenance, by the simple and durable character of all its parts; its adaptability to almost any situation, especially in harbours or tideless seas, by which any area of shallow water could be rendered available as a dock for the largest vessels; its capability of almost indefinite extension, by the use of additional pontoons, or, as regarded the lift, by the addition of extra columns; its rapidity of manipulation with a small staff, by which even vessels in cargo could be docked, with freedom from all strain; and the convenient accessibility it afforded to all parts of a vessel, and especially in painting iron ships their free exposure to light and air. These characteristics were the result of direct experience; others might be indicated. Thus, it was evident the system afforded ready means, by the construction of a shallow canal, of transporting the largest vessels in cargo, either across an isthmus or over shallow rivers, and of removing vessels of war inland, either for their protection or for their employment as a means of internal defence, or for the laying up under shelter, or building, or navigating vessels in any shallow-water space, rendering unnecessary the large area of floating dock accommodation now required, by which a considerable portion of the enormous expenditure which characterised such works might be economised.

ON THE MAINTENANCE AND RENEWAL OF PERMANENT WAY.

By Mr. R. Price Williams, M. Inst. C.E.

The author thought it must be confessed, that the condition of the permanent way, so far as regarded its durability, had in no way kept pace with the demands upon it, and that in this respect it compared unfavourably with other branches of railway engineering. Thus, for instance, whilst the weight and power of locomotive engines had been more than quadrupled in thirty years, the increased efficiency resulting from more perfect workmanship and a better description of material was such, that, on the Great Northern Railway, the per centage on the gross traffic receipts for locomotive expenses had even slightly decreased during the last fourteen years, whereas, on the other hand, that of maintenance of way had increased more than 200 per cent in a similar period.

With a view of showing that the durability of the permanent way, and more especially what was termed the "life of a rail," had been considerably over-estimated, and further with the object of supplying more reliable means for comparing the cost of maintenance and renewals on different railways, the author had been engaged for some years in preparing from reliable sources, tables and diagrams relating to the following lines of railway, arranged according to their mileage:—1. London and North Western; 2. North Eastern; 3. Midland; 4. London and South Western; 5. Great Northern; 6. Lancashire and Yorkshire; 7. South Eastern; 8. London, Brighton, and South Coast; and 9. Manchester, Sheffield, and Lincolnshire. These tables, and diagrams showed, for a period of nineteen years, 1st, the detailed charges of *a*, maintenance of way; *b*, staff and other charges; *c*, works of line; *d*, stations and works; and *e*, renewals of way, all of which were usually comprehended under the head of maintenance and renewal of permanent way and works; 2nd, the number of miles maintained; 3rd, the train mileage; 4th, the gross tonnage, together with other information bearing upon the subject.

The average cost of renewals per mile per annum during a period of years, on the nine railways to which the statistics related, was shown in the following table:—

No.	Name of Railway.	Average of years.	Cost per Mile per Annum.
1	London and North Western	18½	£145
2	North Eastern	14	83
3	Midland	17½	84
4	London and South Western	11	72
5	Great Northern	9½	110
6	Lancashire and Yorkshire	16½	156
7	South Eastern	15½	102
8	London, Brighton, and South Coast ...	12½	94
9	Manchester, Sheffield, & Lincolnshire	9	49

The diagram relating to the London and North Western Railway was explained in detail, and it was remarked, that the cost of maintenance of way had reached £270 per mile per annum, that that of staff and other charges had been regular and uniform throughout down to the present time, that the item works of line showed considerable variation, due probably to the heavy expenditure at times in replacing timber viaducts and repairing slips, and that stations and station works also exhibited the same variable character. It was, however,

in the last item, renewals of way, that the principal disturbauce of outline was noticeable. This was alluded to in periods in the Paper, and the gross result arrived at was, that in the nineteen years £1,906,858 had been expended on renewals of way alone, representing something like 1,362 miles of single line, or almost one-half of the whole mileage maintained in the year 1865. This gave an annual average, since 1847, of £103,000, which was equivalent to nearly 73 miles of single way of the main line broken up and entirely replaced annually during the period referred to, chiefly in situations where the traffic was heaviest, and where consequently, owing to the short intervals between the trains, the facilities for doing the work were the least, and the danger of accident the greatest.

As the diagrams and tables already described were too general in their character to enable a reliable estimate to be formed of the "life of a rail," the author, with the assistance of Mr. R. Johnson (M. Inst. C.E.), had supplemented those relating to the Great Northern Railway, by longitudinal sections of the two principal divisions of the main line, from King's Cross to Peterborough ($75\frac{1}{2}$ miles), and from Peterborough to Askerne Junction ($84\frac{3}{4}$ miles), showing the places where the renewals had occurred, the periods of renewal, and the nature of the different geological formations. Here it was that the destructive effects upon the permanent way of a large and concentrated traffic, more especially of a heavy and rapid coal traffic, were most significantly evident. Various modifications had been rendered necessary in the way as originally laid, and the rails and chairs now used in renewing the road were of a heavier character, and the sleepers were of a larger scantling and were placed closer together. The cost of renewing a single mile of this road, exclusive of ballast, credit being allowed for old materials, was now estimated at £1,372. It appeared that during the last twelve years 315 miles had been entirely renewed on the main line between King's Cross and Askerne junction, at an expenditure of £423,820, being at the rate of £35,273 per annum, which was equivalent to upwards of 1 per cent. on the ordinary stock of the company. In other words, the renewals on the $160\frac{1}{4}$ miles during the period mentioned had amounted to an average cost of £200 per mile per annum. It was explained that the up traffic, including as it did all the heavy coal trains, exceeded that on the down line nearly in the ratio of 2 to 1; and as might naturally be expected, the cost of maintenance and renewals was found to be much in the same relative proportions, 203 miles on the up line having been re-laid, and 112 miles on the down line. Where the different streams of traffic converged, as, for instance, at Hitchin and Hatfield, the frequency of the periods at which the renewals had occurred became very apparent; for the greater part of the up line, on the descending gradients between Potter's Bar and Hornsey, had already undergone a third renewal during the short period of thirteen years, giving an average of only three years and a-half as the life of a rail under these exceptional circumstances. From a return, furnished by Mr. Griuling, it appeared that, on the up line near Barnett, 57,536 trains and 11,760,926 tons had sufficed to destroy in three years the rails laid in 1857, and that 65,529 trains and 13,484,661 tons those laid in 1860 and taken up in 1863.

The results of an investigation made by Mr. Meek, extending over a period of seven and a quarter years, showed that on the Lancashire and Yorkshire, where the traffic was of a heavy character, but conveyed at a low speed as compared with the Great Northern, on the falling gradient of 1 in 130 at Ramsbottom Viaduct, between Bury and Accrington, 62,399 trains and 12,451,784 tons wore out the best sample of rails in seven and a quarter years. At Bolton, on the level, where all trains drew up, the same description of rails had required 203,122 trains and 38,803,128 tons to wear them out in a similar period.

The author considered these facts clearly proved, that the rapid deterioration of the permanent way was in a great measure attributable to the increased weight and speed of the traffic; and that the concurrence of the tonnage outlines with the cost of renewals was collateral evidence of the truth of these deductions. It was contended that the chief materials, the rails, was wanting in the essential element of durability, and that the experiments on the Lancashire and Yorkshire showed, that both the best Yorkshire iron and the coarser and harder descriptions of Welsh manufacture, were alike incapable of withstanding for any length of time the excessive wear and tear to which they were exposed. The mode of manufacturing iron rails, and the various methods of forming the pile adopted at the principal iron works in South Wales, were then described. It was stated that very few makers were now disposed to give even a seven years' guarantee for iron rails, which was tantamount to an admission, that when exposed to the excessive wear and tear of main line traffic, their employment must no longer be looked for.

The introduction of steel rails, manufactured chiefly by what was known as the Bessemer process, and the satisfactory nature of the results obtained, encouraged the belief that in this material had at length been obtained, what was alone wanting to give something like real permanency to that which in name alone had hitherto deserved the title of permanent way. Two steel rails laid in May, 1862, at the Chalk Farm Bridge, on the London and North Western Railway, side by side with two ordinary iron rails, after outlasting sixteen faces of the iron rails, were taken up in August last, and the one face only which had been exposed, during more than three years, to the traffic of 9,550,000 engines, trucks, &c., and 95,577,240 tons, although evenly worn to the extent of a little more than a quarter of an inch, still appeared to be capable of enduring much more work. A piece of one of these rails was exhibited, and another piece had been tested, by Mr. Kirkaldy's machine, the results being recorded in tables and diagrams, showing the comparative strength of steel, steel-topped, and iron rails of different sections.

The general adoption of steel rails on main lines, where the traffic was of the heavy description referred to, would, in the opinion of the Author, not only prove cheaper in the end, but, what was infinitely of greater importance, would, through the less frequent breaking up of the road, materially add to the safety of the travelling public. A tabular statement, which had been prepared by Mr. R. Johnson (M. Inst. C.E.), of the cost of using guaranteed iron rails at £7 18s. per ton, and estimated to last three years, and of steel rails at £15 per ton, supposed to last twenty years, showed a balance of fifty per cent. in favour of steel rails.

The Paper was illustrated by numerous diagrams and specimens of rails, and by an extensive series of tables.

March 6th, John Fowler, Esq., President, in the chair,—twenty-five candidates were ballotted for and declared to be duly elected, including four Members, viz.; Mr. Hugh Carlile, Resident District Engineer on the Duuaberg-Vitepsk Railway; Mr. Edward Read Nelson Druce, Resident Engineer of the Harbour of Refuge Works, Dover; Mr. Richard Hassard, Westminster; and Mr. Robert Morgan, Local Government Act Office; and twenty-one Associates, viz.: Mr. Henry Anderson, Messrs. Penn's factory, Greenwich; Mr. Charles Ormsby Burge, Westminster; Mr. Edward Charles Cracknell, Superintendent of Telegraphs in New South Wales; Mr. William Dempsey, Westminster; Mr. Hamilton Edward Harwood, Westminster; Mr. David Marr Henderson, Messrs. Chance's Lighthouse Department, Birmingham; Mr. Graham Hewitt Hills, Marine Surveyor, Liverpool; Mr. George Knowles, Westminster; Mr. John Lean, Resident Engineer of the Vale of Neath Railway; Mr. James Campbell Ledger, Westminster; Mr. George Leeman, M.P., Deputy-Chairman of the North Eastern Railway Company; Mr. Samuel Henry Louttit, Secretary of Hamilton's Windsor Iron Works Company; Mr. Emile Martin, Adelphi; Mr. Edward Adolphus Fenwick Mayer, late Engineer and Secretary to the Municipal Commissioners of Darjeeling; Mr. Henry Oakley, Secretary to the Great Northern Railway Company; Mr. John Robinson, Bombay; Mr. Thomas Harrison Seacome, Kensington; Mr. George Thornton, Acting Provincial Engineer and Inspector of Roads for the Province of Canterbury, N.Z.; Mr. George Careless Trewby, Superintendent of the Westminster Station of the Chartered Gas Company; Mr. William Vawdry, Resident Engineer of the South Staffordshire Water Works; and Mr. Henry William Wickes, Bromley.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE DEVIATION OF THE COMPASS IN IRON SHIPS.

By ARCHIBALD SMITH, Esq., M.A., F.R.S.

The deviation of the compass is a subject of great and increasing importance, owing to the great and increasing amount of iron used in the construction of vessels, and the consequent increase in the amount of the deviation and in the apparent irregularity of its laws.

On the present occasion it will be necessary for me to omit altogether some of the most important and most interesting parts of the subject, viz. 1st, the mathematical part, including algebraical formulæ, arithmetical processes, and graphic constructions of great interest and utility; and 2ndly, the numerical results for different ships and classes of ships which have been obtained from the reduction and discussion of observations made in a large number of ships of the Royal Navy. I must confine myself to an attempt to explain the principles on which the forces which cause the deviation act, and the principles on which the deviations produced can be reduced to law, and to stating generally what has been accomplished and what remains to be accomplished.

General Considerations.

1. A magnet is a bar of steel, the ends of which have opposite properties. They are generally marked N. and S. (north and south), but to avoid the confusion which would be occasioned by speaking of the magnetism of the north end of the needle or of the north end of the earth as south magnetism, it is convenient to distinguish them as *red* and *blue* (which may be remembered from R occurring in NoRth and U occurring in SoUth).

The property is that the red end of one magnet attracts the blue end and repels the red end of another magnet, and *vice versâ*.

If we lay two magnets at a little distance in the same line with unlike poles turned to each other, and lay a soft iron rod in the interval between them, the soft iron rod will be magnetized by induction: the end next the blue pole of one magnet will become red, the end next the red end of the other magnet will become blue. If we turn the rod about its centre it will gradually lose its magnetism, till, when at right angles to the line of magnetisation, it will be neutral, and if we turn it further, it will become magnetised in the opposite way.

The earth is a magnet, having a blue pole in latitude 70° N., long. 96° W., and a red pole in lat. 75° S., and long. 154° E.

The direction of the magnetic force in London at present is the same as if there were a blue pole $20\frac{1}{2}$° to the west of north, and 68° below the horizon, and a red pole $20\frac{1}{2}$° to the east of south, and 68° above the horizon. This direction is called the line of force, or the line of "dip." If we hold a soft iron rod in the line of dip it becomes instantly magnetised, the north or lower end becoming red, the south or upper end becoming blue. If we hold the rod vertically, the lower end will still be red, but of less intensity, the upper end blue, also of less intensity. If we hold the rod horizontally north and south, the north end will be red, but of still lower intensity, the south end blue, also of lower intensity. If we now turn the rod in the same horizontal plane, its magnetism will diminish till it becomes east and west, when it will be neutral, and if we turn it still further the magnetism will be reversed; the amount of the changes will be greatly increased by hammering the rod in each position. In a rod which I used, the effect was increased by hammering from 12 to 80, or between six and sevenfold. If the iron had been perfectly soft, it results from the experiments of Weber and Thalen that the effect would have been about 36.

A sphere of soft iron will be magnetised in the same way, however held. The

diameter in the line of dip will be the axis of magnetism, and the lower and north half of the surface will be red, the upper and south half blue.

In bodies of any other shape the effects will be similar, though less regular, if the shape be irregular.

In an iron ship, on the stocks, intense magnetism is developed by the process of hammering—red magnetism being developed in the part of the ship which is below and towards the north, and blue magnetism in the part which is above and towards the north.

As the usual position of the compass is near the stern, it follows that in the case of ships built head north, the compass is in a position where there is an intense blue magnetism drawing the north end of the compass strongly to the stern and downwards, and generally producing a very large deviation, besides a large heeling error. In such ships it is of importance to have a standard compass well forward.

In ships built head south there will generally be less deviation, and little heeling error in the usual position of the compass.

In ships built east and west the amount of deviation is generally small, but is less regular than in ships built head south.

Theoretical Representation of the Deviation.

If we place a magnet before the compass with its blue end turned to the compass, it will draw the north end of the needle to the ship's head, and as the ship turns round there will be, in the first or eastern semicircle, a deviation of the north point of the compass to the right hand or east, in the second or western semicircle, a deviation to the left hand or west. This would produce one part of what is called the "semicircular" deviation.

If we place a soft iron rod vertically in front of the compass, with its upper end at the level of the compass, this end, which will be blue, will attract the north end of the needle, and produce a deviation of exactly the same kind as the magnet which we have considered. It will, therefore, simply increase the semicircular deviation caused by the first magnet. If the red end of the imaginary magnet, or the lower end of the imaginary rod, be nearest the compass, or if the magnet or rod be abaft the compass, an effect of the same kind, but in an opposite direction, will be produced.

A magnet to the starboard or port of the compass will produce a similar effect, except that a deviation of one kind will be produced when the ship's head is on the north semicircle, and of the other kind when on the south semicircle. This is the other part of the "semicircular" deviation.

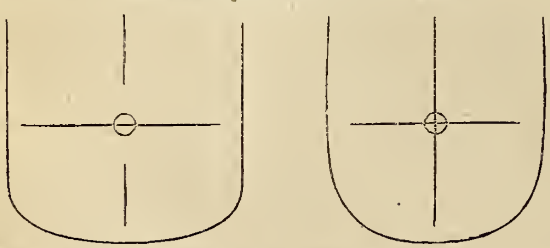
The effects of the two magnets and the one iron rod, which we have considered, make up the whole of what is called the "semicircular" deviation.

If we lay a horizontal soft iron rod in front of and directed to the compass, it will easily be seen that when the ship's head is N., S., E., or W. it produces no deviation. When N.E. and S.W. it produces a deviation to the right hand or E. and when S.E. or N.W. a deviation to the left hand or W., it therefore produces what is called the "quadrantal" deviation.

A horizontal soft iron rod directed to the compass, but placed to the starboard or port, will produce an effect of exactly the opposite kind, and would correct that produced by the first rod; but if the second rod, instead of being on one side, passes, as it were, through the compass, it will produce exactly the same effect as the first rod. The two rods will then conspire to produce the quadrantal deviation.

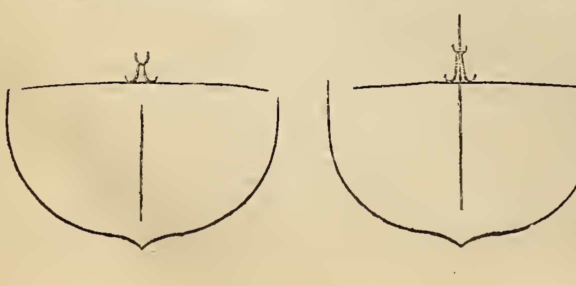
A quadrantal deviation of the same kind will be produced if the first rod instead of being on one side of the compass passes through it, provided always that its force is less than that of the transverse rod.

In almost all known ships the quadrantal deviation is what would be produced by two such rods, *i.e.* rods of one or other of the following types—



Between the two types there is an important difference, which will be easily traced out. The second type would always diminish the directive force of the needle, while the first type would increase or diminish it according as the force of the fore and aft rods is greater or less than that of the transverse rod.

The effect of the magnetism when a ship heels over may be seen by the diagrams which follow.



It will easily be seen that as the ship heels over, the upper end of the transverse rod becomes blue and attracts the north end of the needle to windward, and also that the upper end of the vertical rod which is below in the first figure, by the effect of heeling, is moved to windward, and draws the north end of the needle to windward, and increases the heeling error caused by the transverse beam, while in the second figure it is moved to leeward and counteracts the heeling error caused by the transverse iron.

Compasses on the upper decks of iron ships, particularly if they have been built head north, are of the first type, and there is generally a large heeling error to windward. Compasses on the main deck, and particularly of iron-plated ships, are generally of the second type, and the heeling error is often to leeward.

The amount of error in each case may be easily determined by observations of vertical force, and by separating the two parts of the quadrantal deviation, without actually heeling the ship.

The magnets and soft iron rods we have imagined must not be considered as mere possible cases, but as representing truly the actual case in all ships. They are in fact the physical interpretation of Poisson's general formulæ for the action of induced magnetism, which interpreted amount to this, that the effect of the iron of any body, however irregular, on a magnetic particle, is exactly the the same as that of nine soft iron rods and three magnets. When the iron is symmetrically distributed, as in a ship the rods are reduced five in number, viz. the four we have considered, and a fifth lying fore and aft, with one end below the compass, which would make the heeling error greater or less with the ship's head north than it is with the ship's head south, but this is not an effect of much importance.

Effect in particular Ships.

In wooden ships the semicircular deviation is represented by the effect of a single vertical rod of soft iron in front of the compass, and the quadrantal deviation is very small.

In iron ships the semicircular deviation is generally represented by the effect of a magnet at the part of the ship which was south in building, with its blue end turned to the compass.

Armour-plated ships are generally plated after launching; the semicircular magnetism is greatly affected by the position in which they are plated. If they are plated in the direction opposite to that in which they were built, the deviation is generally diminished; when they are plated in the same position in which they are built, the semicircular deviation is generally increased.

Change of Deviation from Time.

What we have called the permanent magnetism is in truth only subpermanent, and changes much, particularly if the ship is exposed to blows or strains, so that the semicircular deviation generally alters very much in the first year after building. The alteration is generally a diminution, although it might be an increase, if the compass had by accident or choice been placed in a position where the semicircular deviation from induced magnetism exactly counteracted that from the permanent magnetism.

In consequence of this change the Government has, on the recommendation of the Superintendent of the Compass Department, laid down a rule that no iron ship shall be taken up as a transport till it has made one long voyage.

There is a very remarkable change in the capacity of the soft iron for receiving magnetism by induction, which seems to indicate some molecular change in the iron, viz., that it becomes less susceptible of induction by the lapse of time. The effect of this on the strength of the iron is one of the most important points to which attention is now directed.

Change of Deviation from Change of Place.

When a ship sailing south reaches the magnetic equator, the earth's magnetism acts horizontally. The vertical soft iron rod which I have imagined will then have no magnetism, and the semicircular deviation arising therefrom will disappear. When she goes into south magnetic latitudes, the upper end will now become red, and will repel the north end of the needle, and change the direction of the semicircular magnetism caused by the rod.

There will be no corresponding change in the semicircular magnetism caused by the permanent magnetism, except that near the magnetic equator, the directive force of the earth's magnetism being greater than in England, the amount of deviation which the same disturbing force produces will be proportionately diminished.

Careful observations on the changes which take place in the deviation of iron ships in different latitudes are much wanted. They are being made in some of her Majesty's ships now in the south, but there are no means of procuring such observations from merchant ships.

No change is produced in the quadrantal deviation by a change of the ship's geographical position.

Effects of Special Arrangements of Iron.

The upper or lower ends of all vertical masses of iron produce powerful effects on the needle.

The stern posts, iron stanchions, funnels, gun turrets, generally produce large deviations, but if the place of the compass is judiciously selected, they or some of them may be used as correctors.

Horizontal masses of iron, such as deck-beams, produce a great effect, generally increasing the quadrantal deviation and diminishing the directive force. Both causes of error may be reduced by having as little iron as possible immediately below the compass, or within a cone traced out by a line passing through the compass, and making an angle of 54° 45′ with the vertical.

History of the Science.

What has been said will make a short account of the history of the science intelligible. Captain Flinders, in his voyage to Australia in the beginning of

the century, was struck by the fact of the north end of the compass being drawn to the ship's head in northern, and to the stern in southern latitudes. He, with great sagacity, compared it to the effect produced by a vertical rod of soft iron, and corrected it by introducing such a rod abaft the compass.

Afterwards, attention was drawn to the same subject in the voyage of Ross and Parry to Baffin's Bay, to which expeditions General, then Captain, Sabine was attached as astronomer. The very large deviations which were found in high lattitudes attracted attention, and were carefully observed and discussed.

The observations made in these voyages attracted the attention of Poisson, the great French mathematician, who, in his memoirs on magnetism, published in the year 1824, first gave the general formulæ for the effect of iron, which we have already adverted to, and applied them to the observations made in these voyages with much success.

About the year 1840 the British Admiralty, on the report of a committee of scientific officers, comprising General Sabine, Sir J. Ross, and the late Captain Johnson, adopted the system ever since followed in the royal navy, of having a standard compass distinct from the steering compass, placed in a position selected, not with reference to the convenience of the steersman, but for the small and uniform amount of magnetic force at and around it, and of having the deviations of that compass carefully observed by the process of "swinging" the ship, and the deviations of every ship recorded. They also appointed an officer, whose sole or principal duty was the superintendence of the compasses. This office, which has been filled first by Captain Johnson, and since his death by Captain Evans, has done more for the advancement of the science than anything else.

No ships in the royal navy have ever been lost from the errors of the compass; and the magnetic history of every ship is so well known, that, in case of the loss of a ship, there would be no difficulty in arriving at a confident opinion as to the effect of the compass error in using it.

At the same time the attention of Mr. Airy the astronomer royal, was directed to the particular question of the deviation of the compass in iron ships. Mr. Airy proposed a mode of correcting the semicircular deviation by the application of magnets, and of correcting the quadrantal deviation by the application of soft iron cylinders analogous to the soft iron rods we have supposed, which has been subsequently extensively adopted in the mercantile marine.

In the year 1856 the Liverpool Compass Committee commenced those labours which, principally carried on by their able secretary, Mr. Rundell, have produced three valuable reports, which have contributed greatly to the advancement of this science. These labours are, however, now discontinued.

Practice in the Royal Navy.

In the royal navy, as we have said, each ship has a standard compass in a selected position. A ship is swung or turned round, and the deviation observed in a certain number of positions, either by comparison with a compass on shore, or by a comparison with a celestial body, or by observing a distant object. A table of errors is thus observed and recorded; they are reduced by obtaining from them the co-efficients of the semicircular and quadrantal deviation. Observations of horizontal force and of vertical force are also made, from which the amount of heeling error is obtained; and if the amount is large, the heeling error is corrected by the application of a vertical magnet.

The whole process is described, and all the mathematical formula and arithmetical processes, and a number of convenient graphic methods are given in the "Admiralty Manual for ascertaining and applying the Deviations of the Compass caused by the Iron of a Ship." (London: Potter, 1863.)

Practice in the Mercantile Marine.

In the mercantile marine there is no regular superintendence of the adjustment of the compass; it is left to the professional compass adjusters. In many cases there is no separate standard compass, but the steering compass is used for the navigation of the ship, and is often placed so near the stern post and steering gear, that it has originally very large and very irregular deviations. These are corrected by powerful magnets. The consequence is, that the slightest change in the magnetism of the ship produces a large error, which is the more dangerous that the captain believes his compass to be free from error.

This great disadvantage, from the indiscriminate use of the method of correction by magnets is, however, an abuse of the method, and not necessarily attendant on it.

DESIDERATA.

I. *Royal Navy.*

The only desiderata seem to be that greater attention should be paid to the preparing a place for the standard compass, and to the position of the ship in building and plating. The position of the standard compass should be shown in the drawings of every ship, which, before being finally settled, should be submitted for the observations and suggestions of the Superintendent of the Compass Department.

Ships should be built as much as much as possible head south, and should be plated in the opposite direction to that of building.

Careful recommendation as to the special points to be attended to have been submitted to the Admiralty by the present superintendent of the Compass Department, and we may hope that much benefit will be derived from them.

A proof of what may be effected in this way has already been given in the case of several of the ships of the Imperial Russian Navy, in which the arrangements made under the superintendence of Captain Belavenetz have greatly reduced the amount of deviation.

II. *Mercantile Marine.*

This is a more difficult question, from the want of any general superintendence, or any mode of establishing a uniform system, or any opportunity of receiving, recording, reducing, and discussing the observations made.

Till some change takes place in this respect, it is not probable that much improvement will be introduced, or that merchant ships will make their due contributions to the advancement of science.

What seems desirable is,—

1. That in all iron steam passenger ships there should be a standard compass distinct from the steering compass, placed in a position selected for the small and uniform amount of the deviation at and around it.

2. That the deviations by the standard compass should be ascertained and returned to a department of the Government.

3. That these deviations should be carefully recorded, reduced, and discussed by a competent superintendent.

Many indirect advantages might be expected to flow from following, in these respects, the example of the Royal Navy.

Foreign Countries

The "Admiralty Manual" has been translated with more or less modification, and in some respects improvement; by M. Darondeau into French, Captain Belavenetz into Russian, and Dr. Shaub (of the Austrian Hydrographic Department) into German. In Russia, in particular, the great zeal of Captain Belavenetz, and above all, the appointment of a person of his energy and ability, charged exclusively with the suprintendence of this branch of nautical science, has produced, and promises to produce, most important results. In the French and other navies it is not understood that there is any officer charged exclusively with the duty, and we cannot therefore at present look for any contributions from them to the science of the deviation of the compass.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The ordinary monthly meeting of members of this society took place at their rooms in Doctors' Commons, City, on the 3rd ult., Mr. Joseph Newton, president, in the chair. The early part of the sitting was occupied with the reception of the minutes of the preceding meeting, the election of a considerable number of new members, ordinary and honorary, and a discussion upon the progress and prospects of the institution. In the course of the latter it was suggested that the time was approaching when it would be necessary to consider the propriety of obtaining a more commodious place for assembling, and, in fact, of establishing a Foreman's Hall. This, if accomplished, it was said, would remove the objections, which some employers were known to entertain, to sharing in the deliberation of the members, and thus add materially to the prosperity of the association. We cannot but agree with this idea, for a tavern, however well conducted, is scarcely a fit place for the consideration of scientific questions, or for carrying on the ordinary business of a scientific society. It is hardly to be doubted that if the foremen engineers of the metropolis were to exert themselves in the direction indicated, they would meet with the moral and material co-operation of their masters—at least, they would deserve it. The paper read on the 3rd ult. was a very lengthy one, written by Mr. J. M. Oubridge (of Messrs. Simpson's, Pimlico), on the "Various Modes of Smelting Iron and their Results." The author prefaced his remarks upon the subject by some observations as to the desirability of a yet closer union between employers and foremen, in order the more effectually to stem the tide of foreign competition in the several branches of engineering science, and which was advancing with great force. If the employers of mechanical labour consulted more frequently with those who were intrusted with the realisation of designs, and the reduction of theory to practice, all would benefit by the arrangement, and they need have little fear of "the foreigner." Mr. Oubridge then proceeded to trace the history of iron smelting from the very earliest periods of recorded time, and by means of diagrams, which he drew *en courant*, illustrated clearly the gradual progress of improvement down to our own day. As a practical ironfounder, the author recounted much of his own experience, and said that the great secret of economical and effective smelting consisted in obtaining for the purpose a rapid current of common air, so as to produce complete combustion of the fuel employed; and the speedy creation of a large quantity of carbonic oxide gas was the consequence of such an arrangement. The blast pipes should in all cases fit the tuyere holes closely, so as to prevent the waste of air, and to direct the full force of the current into the furnace. It was also desirable to adopt what was known as the "drop bottom" in furnaces, so much used in America, and he was sorry to say as yet so seldom adopted in this country. It was desirable to lessen, as far as possible, the expenditure of manual labour, and this last arrangement was essentially a step in that direction. After a man had been engaged in working a furnace for several hours, it was rather hard to give him the task of raking it out and quenching it. By means of the drop bottom this might be accomplished in a few minutes, whereas it was a laborious and tedious process in the other case, and much more costly. Mr. Oubridge concluded his paper with some statistics in regard to melting operations in the establishment with which he was connected, and resumed his seat amidst the plaudits of his fellow members. A discussion, which the lateness of the hour prevented extending to any length, followed. In this Mr. Keyte and Mr. Briggs shared, but finally, and after a vote of thanks had been awarded to Mr. Oubridge, it was adjourned until the next meeting of the Society.

ROYAL SOCIETY.

ON TESTING CHRONOMETERS FOR THE MERCANTILE MARINE.

By John Hartnup, F.R.A.S., Director of the Liverpool Observatory.

The late Admiral Beechey, on looking over the records of the Liverpool Observatory in 1854, was strongly impressed with the importance of some systematic plan being adopted for testing the chronometers employed in the mercantile marine. He consulted many persons on the subject who were interested in the security of navigation, but the difficulty which presented itself at that time was the long period required for the test, five or six months at least being supposed to be necessary.

About four years ago the Mersey Docks and Harbour Board gave me permission to have constructed, for the purpose of testing chronometers, a hot-air apparatus on a more convenient principle, and on a much larger scale than the one which I had heretofore employed; and the arrangements are now so perfect that chronometers can be tested efficiently in five weeks. It appears that chronometers in the merchant service, when at sea, are generally exposed to temperatures ranging from about 55° to 85° of Fahrenheit, and that for most practical purposes it is sufficient for the shipmaster to know the rate in the three definite temperatures 55°, 70°, and 85°. The following examples, taken from our records, will illustrate the method I have devised to supply this information. The temperature is changed 15° on Saturday mornings. No comparisons being made on Sundays, the rate for Monday in each week is the mean of two days.

Table I.—Showing the daily rates, gaining, of six chronometers for five weeks ending February 21.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Mean daily temp.
	s	s	s	s	s	s	°
January 19	0·5	0·6	3·4	2·8	1·3	2·5	55
„ 20	0·6	0·7	3·5	3·1	1·1	2·9	55
„ 21	0·9	0·5	3·6	3·0	1·0	2·9	55
„ 22	0·9	1·0	3·5	3·1	1·3	2·5	56
„ 23	0·5	0·9	3·5	3·1	1·4	2·2	55
„ 24	0·6	0·8	3·6	3·0	1·1	2·3	55
Means	0·67	0·75	3·52	3·02	1·20	2·55	55
January 26	1·2	1·1	1·8	2·1	3·3	2·1	70
„ 27	1·2	1·4	1·8	2·0	3·3	2·2	70
„ 28	1·2	1·5	1·9	2·3	3·3	2·5	70
„ 29	1·2	1·6	2·1	2·3	3·1	2·3	70
„ 30	1·0	1·7	1·9	2·3	3·1	2·5	70
„ 31	0·9	1·4	2·0	2·2	3·4	2·7	71
Means	1·12	1·45	1·92	2·20	3·25	2·38	70
February 2	0·8	0·7	0·8	0·4	4·3	4·4	85
„ 3	0·7	0·8	0·9	0·5	4·3	4·8	85
„ 4	0·7	0·6	0·8	0·6	4·1	4·6	84
„ 5	0·4	0·7	0·7	0·3	4·0	4·3	85
„ 6	0·6	0·6	0·7	0·5	3·9	4·3	85
„ 7	0·9	0·9	0·9	0·6	3·9	4·3	85
Means	0·68	0·72	0·80	0·48	4·08	4·45	85
February 9	1·1	1·2	2·1	2·3	2·8	2·2	70
„ 10	1·3	1·3	1·7	2·3	2·9	2·1	70
„ 11	1·6	1·4	1·7	2·4	3·0	2·2	70
„ 12	1·4	1·6	2·2	2·6	2·8	2·3	71
„ 13	1·5	1·2	2·1	2·3	2·4	1·7	69
„ 14	1·5	1·2	2·2	2·4	2·4	1·8	69
Means	1·40	1·32	2·00	2·38	2·72	2·05	70
February 16	1·0	0·6	3·6	3·4	0·5	2·8	55
„ 17	0·9	0·4	3·9	3·3	0·3	2·5	55
„ 18	0·9	0·8	3·9	3·5	0·4	2·3	55
„ 19	0·6	0·4	3·6	3·3	0·4	2·1	55
„ 20	0·8	0·7	3·4	3·6	0·3	2·3	56
„ 21	0·7	0·9	3·9	3·6	0·7	2·6	56
Means	0·82	0·63	3·72	3·45	0·43	2·43	55

From these six examples, the following results for the middle period of the test are deduced:—

Table II.—Showing the mean daily rates, gaining, in three definite temperatures.

Mean temperature.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	s	s	s	s	s	s
55	0·75	0·69	3·62	3·24	0·82	2·49
70	1·26	1·39	1·96	2·29	2·99	2·22
85	0·68	0·72	0·80	0·48	4·08	4·45

Table III.—Showing the weekly increase of gaining-rate deduced from the first and last weeks of the test.

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
s	s	s	s	s	s
0·04	—0·03	0·05	0·11	—0·19	—0·03

The efficiency of the method will be seen by the following three examples, in which the test was repeated four times in succession.

Table IV.—Showing the mean daily rates, gaining, of three chronometers tested in three definite temperatures four times in succession.

Middle period of test.	No. 1.			No. 2.			No. 3.		
	55°	70°	85°	55°	70°	85°	55°	70°	85°
	s	s	s	s	s	s	s	s	s
November 12	2·4	2·2	1·1	0·7	1·6	1·5	1·5	1·4	0·8
December 10	2·5	2·3	1·3	1·4	2·2	2·0	1·8	1·6	1·0
January 7	2·6	2·6	1·5	1·7	2·4	2·3	1·9	1·7	1·2
February 4	2·8	2·5	1·4	1·7	2·5	2·3	1·9	1·6	1·0

The preceding examples have not been selected to show the large errors in a ship's longitude which might result from the use of very bad instruments, but rather that in what are considered good and carefully regulated chronometers errors may, with adequate means for testing, be detected, and tables of corrections supplied to the mariner.

Examples 1 and 2, Table I., show how nearly it is possible to compensate for change of temperature between 55° and 85°. Some chronometers so compensated, when exposed to a temperature of 40°, change their rates very much, while in others the alteration of rate is comparatively small.

On ascertaining the chronometrical difference of longitude between the Liverpool Observatory and the Observatory at Cambridge, Massachusetts, the late Professor W. C. Bond at the commencement employed twelve marine chronometers which had been used previously on several occasions for obtaining differences of longitude. During the voyages between Liverpool and Boston, in the summer months, the sea and shore rates of these chronometers were sensibly the same; but during the winter months they differed considerably. On testing these instruments in 40° and 60°, the following results were obtained:—

Table V.—Showing the increase of gaining-rate of twelve chronometers caused by changing the temperature from 40° to 60°.

No.	Increase of mean daily rate, gaining.	No.	Increase of mean daily rate, gaining.
	s		s
1	7·6	7	3·0
2	5·6	8	2·7
3	4·8	9	1·5
4	3·7	10	1·3
5	3·4	11	0·3
6	3·0	12	—3·5

The chronometers alluded to in this table were made by the late Mr. Dent, and used by him for finding the longitudes of several observatories in this country.

On testing 100 chronometers in succession as they passed through the Observatory, the average alteration of daily rate caused by changing the temperature from 40° to 60° was 7s 0; and in ten per cent. of the hundred the average change was 30s 6.

The chronometer-room at the new Observatory now being erected at Bidston by the Mersey Docks and Harbour Board will be provided with the means of testing simultaneously between two and three hundred chronometers, in the way shown by the examples in Table I. It is not necessary to test chronometers in this elaborate way on every occasion that they arrive in port, as the corrections for change of temperature remain the same for a long period. The *rate* may change, as in example 2, Table IV., while the thermal correction remains sensibly the same.

When the Greenwich mean time is communicated from an authorised establishment, as is now generally the case in our large sea-ports, the rates of chronometers in the temperature that prevails at the time can be easily ascertained. At present these rates are used on the assumption that the thermal adjustments are perfect. The corrections for change of temperature in Table II. show the improvement which might be effected by testing all chronometers when new, and supplying mariners with tables of such corrections as may be found to exist. These corrections would require verifying periodically, as in cleaning and repairing timekeepers the thermal adjustment is sometimes altered.

ON THE EXPANSION OF WATER AND MERCURY.

By A. Matthiessen, F.R.S.

Before commencing a research into the expansion of the metals and their alloys, it was necessary to prove that the method I intended to employ, namely, that of weighing the metal or alloy in water at different temperatures, would yield good and reliable results.

To check, therefore, the method, I was led to determine the co-efficient of expansion of mercury, and, basing my calculations on Kopp's co-efficients of expansion of water, I expected to obtain Regnault's co-efficient of expansion of mercury. The co-efficient deduced from experiments did not agree with Regnault's; and, being unable to discover any source of error in the method of experimenting, I determined to reinvestigate the matter.

The memoir is divided into four parts.

I. On the determination of the co-efficients of the linear expansion of certain glass rods.

These rods (1825 millims. long and of 20 millims. diameter) were kindly made for these experiments by Mr. F. Osler. The method used for the determination of their increment in length was that of measuring it with a micrometer-screw, with which a length could be measured with accuracy to 0·001 millim.

The rod was placed in a long trough, the one end of the rod resting against a fixed glass tube capped with zinc, the other against another glass tube, the other end of which rested against the micrometer-screw. Water was allowed to flow through these glass tubes during the time of observation. The trough being filled with water at ordinary temperature and the position of the screw read off, the water was heated to boiling and another reading taken.

The mean of sixteen observations gave for the linear expansion of these rods

$$L_t = L_0\,(1 + 0{\cdot}00000729t),$$

and therefore for the cubical expansion

$$V_t = V_0\,(1 + 0{\cdot}00002187t).$$

II. On the method employed for the determination of the cubical expansion of water and mercury.

This part of the paper contains a full description of the apparatus employed and the precautions taken.

The method consists of weighing the substances in water at different temperatures, and from the loss of weight in water deducing its volume. For this deduction, the expansion of water at different temperatures is required.

III. On the redetermination of the co-efficients of expansion of water.

To determine these, pieces of the glass rods (the linear expansion of which had to be determined), ground to the shape of a double wedge, were weighed in water of different temperatures. Three pieces of glass were used (making three series), the weighings being made at temperatures between 0° and 100°, the whole number of observations being thirty-two.

From these it was found that the expansion of water between 4° and 100° may conveniently be expressed between 4° and 32° by the formula

$$V_t = 1 - 0{\cdot}0000025300\,(t-4) + 0{\cdot}0000083890\,(t-4)^2 - 0{\cdot}00000007173\,(t-4)^3,$$

and between 32° and 100° by

$$V_t = 0{\cdot}999695 + 0{\cdot}0000054724t^2 - 0{\cdot}000000011260t^3.$$

The values calculated from these formulæ for the volume occupied by water at different temperatures are given in Table I. from degree to degree, together with the differences for each degree.

IV. On the redetermination of coefficient of expansion of mercury.

The pure mercury was weighed in a bucket in the water at different temperatures. The glass bucket was made from the end of a test-tube (its length being about 20 millims. and width 15 millms.). The expansion of this sort of glass was found to be

$$V_t = V_0'\,(1 + 0{\cdot}00002566t).$$

Five series were made with mercury; and its expansions, deduced from the water-expansions given in Table I, were

Series I..........$V_t = V_0\,(1 + 0{\cdot}0001815t)$,
Series II..........$V_t = V_0\,(1 + 0{\cdot}0001813t)$,
Series III..........$V_t = V_0\,(1 + 0{\cdot}0001808t)$,
Series IV..........$V_t = V_0\,(1 + 0{\cdot}0001808t)$,
Series V..........$V_t = V_0\,(1 + 0{\cdot}0001816t)$,
Mean......$V_t = V_0\,(1 + 0{\cdot}0001812t)$,

a value closely agreeing with Regnault's, namely

$$V = V_0\,(1 + 0{\cdot}0001815t).$$

Calculating from the five series the coefficients of expansion of mercury, using Kopp's water expansion (taking the volume at 4° = 1), we find as mean

$$V_t = V_0\,(1 + 0{\cdot}000178t).$$

Table I.

T° C.	Volume of water at T°.	Difference per 1°.	T° C.	Volume of water at T°.	Difference per 1°.	T° C.	Volume of water at T°.	Difference per 1°.
4	1·000000	0·000006	37	1·006616	0·000355	69	1·022050	0·000591
5	1·000006	22	38	1·006979	363	70	1·022648	598
6	1·000028	38	39	1·007351	372	71	1·023252	604
7	1·000066	53	40	1·007730	379	72	1·023861	609
8	1·000119	69	41	1·008118	388	73	1·024477	616
9	1·000188	83	42	1·008514	396	74	1·025099	622
10	1·000271	98	43	1·008918	404	75	1·025727	628
11	1·000369	110	44	1·009331	413	76	1·026361	634
12	1·000479	125	45	1·009751	420	77	1·027000	639
13	1·000604	138	46	1·010179	428	78	1·027646	646
14	1·000742	150	47	1·010614	435	79	1·028296	650
15	1·000892	162	4	1·011059	445	80	1·028953	657
16	1·001054	173	49	1·011510	451	81	1·029615	662
17	1·001227	185	50	1·011969	459	82	1·030283	668
18	1·001412	196	51	1·012435	466	83	1·030956	673
19	1·001608	206	52	1·012909	474	84	1·031634	678
20	1·001814	215	53	1·013391	482	85	1·032318	684
21	1·002029	225	54	1·013879	488	86	1·033007	689
22	1·002254	234	55	1·014376	497	87	1·033701	694
23	1·002488	243	56	1·014879	503	88	1·034400	699
24	1·002731	251	57	1·015390	511	89	1·035104	704
25	1·002982	259	58	1·015907	517	90	1·035813	709
26	1·003241	266	59	1·016432	525	91	1·036527	714
27	1·003507	273	60	1·016964	532	92	1·037245	718
28	1·003780	279	61	1·017502	538	93	1·037969	724
29	1·004059	286	62	1·018047	545	94	1·038697	728
30	1·004345	290	63	1·018599	552	95	1·039429	732
31	1·004635	296	64	1·019158	559	96	1·040166	737
32	1·004931	318	65	1·019724	566	97	1·040907	741
33	1·005249	329	66	1·020296	572	98	1·041653	746
34	1·005578	338	67	1·020874	578	99	1·042404	751
35	1·005916	0·000345	68	1·021459	0·000585	100	1·043159	0·000755
36	1·006261							

In Table II. I give the values obtained by different observers for the volumes occupied by water at different temperatures, the volume at 4° being taken equal to 1.

Table II.

T.	p.*	Despretz.†	Pierre.‡	Hagen.§	Matthiessen.
4°	1·000000	1·000000	1·000000	1·000000	1·000000
10	1.000247	1·000268	1·000271	1·000269	1·000271
15	1·000818	1·000875	1·000850	1·000849	1·000892
20	1·001690	1·001790	1·001717	1·001721	1·001814
30	1·004187	1·004330	1·004195	1·004250	1·004345
40	1·007651	1·007730	1·007636	1·007711	1·007730
50	1·011890	1·012050	1·011939	1·011991	1·011969
60	1·016715	1·016980	1·017243	1·017001	1·016964
70	1·022371	1·022550	1·023064	1·022675	1·022648
80	1·028707	1·028850	1·029186	1·028932	1·028953
90	1·035524	1·035660	1·036421	1·035715	1·035813
100	1·043114	1·043150	1·043777	1·042960	1·043159

* Pogg. Ann. xcii., 42. † Ann. de Chim. et de Phys. lxx. (1re sér.) 1.
‡ Ann. de Chim. et de Phys. xiii. (3me sér.) 325. Calculated by Frankenheim, Pogg. Ann. xcvi. 451.
§ Abhandlungen d. k. Acad. der Wissenseh. zu Berlin, 1865.

Kopp, Despretz, aud Pierre used the same method for their determinations—that of determining the expansion of water in glass vessels (dilatometers). Hagen employed the weighing process, but at high temperatures employed no special precautions to prevent the steam condensing on his fine wire; hence his values at 90° and 100° fall below mine.

It will be seen from the foregoing table that Kopp's values are lower than the others; and bearing in mind that the coefficient of expansion of mercury, when deduced by means of these, falls below that obtained by Regnault, but when deduced from Despretz's or my own agrees closely with Regnault's, we are led to conclude that Kopp's values must be somewhat incorrect.

THE SUGAR QUESTION.

This question has been before the public in a variety of shapes. It has taxed at once our purses and our humanity; it has bathed the mother in hot-tears, and wrung the widowed aching heart with intenser anguish; the home of the negro has been despoiled, and he has been chained in slavery; the husband or brother was killed in defending a wife or sister from brutality of a deeper stain. Other men of whiter skin accumulated riches as a consequence, and enjoyed the luxuries which those riches afforded. In a word sugar introduced us to slavery and to luxury growing on the same soil and under the same roof. The bond between the two was law; when that bond or law was relaxed in sympathy with the negro, he became his own master. Good men indulged the hope of good results as usual, and as usual we find the tares among the wheat; the negro is still worked in a tropical climate to please himself or to satisfy his necessities.

The necessities of the negro may not be compared to the luxuries of the slave owner. Neither the necessities of the one, nor the luxury of the other, inclined either of them to alter, but to perpetuate thinga ss they found them, and they have been perpetuated to this day, with but little amelioration from without.

Napoleon I. had been deprived aforetime of his sea-borne commerce when his *savants* sought for, and obtained a home made sugar from the home grown beet root. Their success and the encouragement which followed after it, knit these able chemists more closely to their tail. The efforts of French, Belgian, and Prussian chemists have been increasing in this direction, and most welcome to the beet growers and sugar producers. The natural result is an accumulation of knowledge, of manufacture, and such a consequent increased product of sugar, obtained from the beet root of France, Belgium, &c., that there is an excess over the demand for home consumption. Being grown and converted into sugar with a proper regard to economy, and in conformity with those laws which chemistry unfolds, and science demonstrates daily, we may not remain astonished at the information that sugar, so produced, can be, and is sold cheaper than cane sugar. When all the cheaper beet root sugar is bought up, then the cane sugars will be sold. If the beet root product goes on increasing, then there must follow an increasing impediment to the sale of cane sugar, at least so long as there remains a difference of price in favour of the beet sugar. These sugars differ in no other respect than their price.

We may not avoid the blurting out of the humiliating fact, that cane uice contains double the quautity of sugar that is sold. There is quite as much wasted in the primary manufacture as there is sold. If the planter is content to waste his sugar, there can be no objection on the part of the public. What the public hesitate to do, is to pay such a price for sugar as can cover a wilful loss of sugar. They claim to prefer the cheaper Belgian sugar, until the cane sugar is the cheaper, as it ought to be.

Railways in the Danubian Principalities.—The concession recently obtained by Mr. Barclay for the construction of a railway between Bucharest and Giurgevo has been cancelled by the Moldo-Wallachian Chamber.

Self Acting Clocks.—Valuable Discovery.—A novel application of electro-magnetism, as a motive power for clock-work, has just been perfected by Mr. Bright, of Leamington, which promises to introduce a new era in the science of clockmaking, and bring modern time pieces to a state of absolute perfection. By the new arrangement, the pendulum, the bob or ball of which consists of an electro-magnetic coil, is made to oscillate by means of a feeble current of electricity, thus beating true seconds, with a train of wheels only. One of the advantages of this system is that a number of clocks, in different parts, or even in different houses, can be connected together by a single wire, and the whole number will indicate the same time to a second. The clocks are of the simplest construction, and never need winding up. No acid battery is used. Mr. Bright, the discoverer, has secured the plan by patent. The clocks are spoken of as being far superior to the present clocks in use.

REVIEWS AND NOTICES OF NEW BOOKS.

A Descriptive Treatise on Mathematical Drawing Instruments, &c. By William Ford Stanley, Mathematical Instrument Maker to H.M. Government, &c. London: Published by the Author, 5, Great Turnstile, Holborn.

We have here a description of the qualities, and some of the uses of Mathematical Drawing Instruments, written in a plain, clear, concise style; so plain and clear, that no intelligent youth can possibly mistake what he here may read in descriptive text, and is further explained in very neatly executed woodcuts. He should read this book before he took "pen in hand." It would save him from many silly inquiries when he becomes master of instruments, such as this book teaches him to prefer for their usefulness. We recommend the book to the inquiring pupil and student in drawing.

Diagrams, giving Weights of Iron Girders. By B. Baker. London: E. and F. N. Lyon, Bucklersbury.

The author must have great experience in the construction of girder bridges, or must have had access to very good and numerous sources from which to draw materials which may justify him to offer these diagrams for use to the members of the profession, as giving a sufficient degree of accuracy for all practical purposes.

The contractor who estimates and works from drawings with dimensions well defined will, we are inclined to think, not resort to their use; but if Mr. Baker can but convince the civil engineer of the correctness of his diagrams, the latter will not fail to make good use of them, and will find them a valuable adjunct to his "pocket book." In order to beget that confidence which is required before men will make use of an instrument (for such they may be called), the results obtained by which cannot be checked except by the laborious process which it offers to do away with, it would have been well had Mr. Baker accompanied his diagram plate with a short introduction, stating whence the data from which the diagrams were constructed have been derived, and otherwise showing that they really give the weights of "girders of average construction." Our time has not permitted us to test their accuracy, which, however, we have no reason to doubt; but we believe the engineer would gladly have paid for the additional expense of such an introduction, in which, moreover, the author might have dilated more largely upon the various uses for which the diagrams are suited, and multiplied the number of his examples for the benefit of those who intend to have recourse to their assistance.

A Turret Navy for the Future An Appeal to the Parliament of 1866. By Rear-Admiral Halstead.

Under this title Admiral Halstead publishes a couple of letters that had appeared in the *Daily News* and in the new technical paper *Engineering*, in which he propounds his ideas on a first-rate man-of-war, armed on the turret principle, and which views are shown to have been favourably commented upon by men of undoubted eminence in their respective professions. In our opinion, the problem to the solution of which the Admiral appears to have devoted considerable time is eminently one upon which experiment alone can speak authoritatively, and if he can induce Parliament to vote the funds for such an experiment, we wish the Admiral's scheme every possible success, either on the coasts of Denmark or on those of North America. The British nation is quite able to pay for it.

On the necessity for the complete decoloration of Cane Sugar in the Colonies, &c. By Armand Montclar, C.E., Java. Glasgow:—Bell & Bain, 41, Mitchell-street.

"All the world" seem to be up, because sugar is down. Anxious inquiries occur daily, about the relative prospects of the saccharine products of sugar-cane and of beet-root. We do not hesitate to express our conviction that the sugar-cane need not permit the beet-root to supersede it; whilst the planters are offered the doubling of their sugar produce, whenever they will accept experience for a guide, in preference to blind routine.

Our author here contends for "complete decoloration of cane-sugar in the Colonies," and for the superior economy of his "patent decoloring composition." He has relieved the monotony of his argument by rambling occasionally, whither we need not follow him. "He has for *twenty* years strenuously advocated the adoption of *powerful and complete* decoloration by the Colonial sugar manufacturer." Now, it is generally held that an argument, to be of value, must be consistent. At page 15 of his pamphlet we read, "If the author's system is carried out generally, a splendid white sugar will be manufactured directly and ready for general consumption. Then the greatest colonial trade will be secured for ever!—probably injuring to a slight extent the few European refineries, but immensely benefiting some 300,000,000 consumers!" and, without going

beyond asserting this "immense benefit," we find in the very next page these words, "colonial sugar will always require some little of the refining process in Europe." Where, then, is the value of all this "powerful and complete decoloration," or of the patent composition to produce this "powerful" effect? We are told somewhere of Jack raising a wonderful bean stalk, and he had the pleasure of cutting it down again. Why, may we ask, make the attempt for a "splendid white sugar" in the Colonies, when it is sure to be rifled of its purity on its voyage hither, and "will always require the refining process in Europe."

On the patent composition we are left unmercifully in the dark, beyond its pretensions. We certainly have translations of certificates which allude to "Mr.Montclar's system." One of the writers has "no hesitation in certifying that the object in view is to prevent the annual loss of animal charcoal, and it has been fully obtained."

The very proper caution with which the respected Professor Penny, of the Andersonian University, Glasgow, approaches the subject, betrays a knowledge of the many failures hitherto attending the practical use of substitutes for animal charcoal, in the operation of refining sugar. There are many chemical operations in which vegetable or mineral carbon can effect all that is required. Into this part of the question we need not enter now, nor need we define the particular requirement for sugar as it commonly occurs. The refiners on the Clyde would also seem to be very cautious in their approaches. They appear to know that "during the last forty years, various chemical agents have been proposed for decolorising sugar, without animal charcoal; but hitherto ALL have been practical failures." They have been using, and will prefer to use, the beet-root sugar, simply because it leaves a larger margin of profit. The relative value of beet and cane as sugars is identical, but they differ in cost, the beet-root sugar being the cheaper. Our author's composition is proximately cheaper than animal charcoal, and will assuredly supersede animal charcoal, whenever experience shall have confirmed that value, not before. It will not be sent from the Clyde, whenever it can be used there to a considerable profit.

In conclusion, if we take an extract from that valuable and expensive book, "personal experience," it may supersede the necessity here for something longer on vegetable chemistry, however applicable to this subject and interesting that beautiful science might be. We have seen, in a Spanish Colony, situate in the locality of Java, an extensive establishment reared up and well furnished with steam engines and vacuum pans, and animal charcoal filters in abundance, together with all those usual accessories. It duly turned out large quantities of that splendid class of white sugar, with which our author is so keenly enamoured. It (the establishment) now turns out *Tobacos de primera clase.* Thus did this extensive arrangement for first class white sugar literally end in *smoke.* This was all accomplished within the space of ten years. Everything was conducted by gentlemen selected for their experience in London, or Paris, or Brussels. There did not occur the risk of novelty, of course not. It was simply the perpetuation of current ideas, and time-honoured practice. How far the great saving, claimed by our author, in the use of his "patent composition" might have gone to secure the desired profit, is a very simple matter for calculation, although spread over an expenditure of some hundreds of thousands of dollars. It would be truly desirable if the proof were as satisfactory as simple, now when the beet-sugar is taking such a formidable position by reason of its greater economy to the buyer. We take leave to doubt it, and to urge the planters to submit their process to revision. Hitherto the engineer has been working at one end of the process and the chemist at the other end. There will be perfect accord, and simultaneous action whenever this delicate and intricate subject is successfully treated. This is by no means impossible, for it can be comprehended in detail and in its completeness, although very few have taken so much trouble about it.

Engineering Facts and Figures for 1865. Annual Register of Progress in Mechanical Engineering and Construction. Edited by ANDREW BETTS BROWN, Mechanical Engineer. London and Edinburgh: A. Fullarton and Co. 1866.

This valuable annuary has just entered on the third year of its existence. It treats, in thirteen divisions, the process of mechanical engineering during the past year. The heads: steam engines, boilers, and fuel have the lion's share, as they occupy upwards of one-half of the volume; the other sections relate to general machinery and working tools, metallurgy and metal manufactures, railways, ships, telegraphs, agricultural and general engineering. Having received this volume only just before going to press, we are precluded from giving it a more extensive notice, but we may be allowed to add that the plan on which Mr. Brown's publication is compiled is eminently adapted for reference, that his work gives a very exhaustive view of the subjects on which it treats, and will prove an excellent *vademecum* for all members of the engineering profession who are anxious to keep themselves *au courant* of the most modern improvements in its various departments, chiefly as regards the generation of steam and application of steam power. The more ample notice that is given in this work to the construction and working of steam boilers contrasts favourably with the insufficient attention paid to this most important subject in many works of a similar character.

Results of the Creosoting Process for Preserving Timber under Mr. John Bethell's Patent. Bath: Geo. H. Wood. 1866.

In this pamphlet we find various information on Mr. Bethell's process of impregnating timber used for railway sleepers, telegraph poles, and other purposes. The process of creosoting is thus described:—

"The timber, being first dried, and cut according to the pattern required, is carefully weighed, and is then placed in a cylinder of wrought iron, the doors of which are hermetically closed. The air and the moisture contained in the wood are then exhausted from it, and from the cylinder containing it, by a powerful air pump. The pores of the wood being now empty, and capable of being absolutely filled, the preservative material, called creosote oil (which consists of the heavy bituminous oils distilled from gas-tar and pitch), heated up to 120° Fahr., is forced into the body of the timber by powerful hydrostatic pumps, exerting a pressure of 120 to 200lbs. per square inch. This pressure is maintained until it appears that the proper quantity of creosote oil has entered into the wood. The wood is then taken out and weighed, to verify the result.

Timber for railway sleepers, bridges, &c., must absorb at least 7lbs. of creosote per cubic foot; and timber, to be protected against marine worms, insects, &c., requires at least 10lbs. per cubic foot.

The price charged for creosoting is from 4d. to 6d. per cubic foot, according to the quantity of oil required.

Mr. Bethell has reason to believe that, since the expiration of his patent, much timber has been prepared with less than the above proportion of creosote oil, and that in some cases timber has even been prepared by simply steeping it in creosote oil; but he takes occasion to observe that neither of these practices has been in any way sanctioned by him, and that he does not believe they will prevent the internal rotting of the timber."

It appears that Mr. Bethell's process has met with considerable success both in this country and on the Continent.

Improvements in Apparatus employed in the Manufacture of Gas. By GEORGE ANDERSON, Gas Engineer, Londom.

We have received this pamphlet, the contents being in the shape of a letter addressed by the author "To the Secretaries and Engineers of Gas Companies."

The author is well qualified to speak authoritatively upon the important subjects to which the pamphlet refers, as he states:—that he has graduated practically throughout the various stages of the profession, having had the advantage of a mechanical education to start with;—that during the last twenty years having been so engaged, he has seen many things which he thought could be improved; and that he has not hesitated to attempt their improvement, with a result that has cheapened both the construction of works and the cost of manufacturing Gas.

Mr. Anderson proceeds to give a very interesting *resumé* of his lengthened experience in the construction of gas works and the manufacture of gas, and gives the practical results which have arisen from the introduction of his improvements. The pamphlet is illustrated by several drawings of Mr. Anderson's various improvements in apparatus employed for, or used in connection with the subjects upon which the pamphlet treats.

The author very candidly states that he has realized considerable pecuniary benefit to himself, by the improvements which he has effected.

We recommend a careful perusal of this pamphlet to those who, as capitalists, desire to make the most of their property, consistent with a due fulfilment of those onerous duties which are required of them by the public; and to engineers who are willing to adopt an improvement, as opportunity arises, whenever they are convinced that it is an improvement.

BOOKS RECEIVED.

"A Treatise on the Screw Propeller." By JOHN BOURNE, C.E. Part IV., containing the History of the Screw Propeller up to 1852.

NOTICES TO CORRESONDENTS.

C. E.—Your suggestion for converting the River Thames into a dock from Greenwich upward is not a new idea. Some years ago Mr. N. Gould stated in the mechanical section of the British Association that a Mr. Dodd or Dodds had some twenty years previously published plans, &c., for carrying the project into effect, and he mentioned the name of Mr. Brayley, the Secretary of the London Institution, as one who is cognisant of the details of the scheme.

R. J. and others.—We are compelled to defer giving answers until our next.

PRICES CURRENT OF THE LONDON METAL MARKET.

	March 3.	March 10.	March 17.	March 24.
COPPER.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Best, selected, per ton	99 0 0	99 0 0	99 0 0	94 0 0
Tough cake, do.	96 0 0	96 0 0	96 0 0	91 0 0
Copper wire, per lb.	0 1 0½	0 1 0½	0 1 0½	0 1 0
„ tubes, do.	0 1 1¼	0 1 1¼	0 1 1¼	0 1 1¾
Sheathing, per ton	101 0 0	101 0 0	101 0 0	96 0 0
Bottoms, do.	106 0 0	106 0 0	106 0 0	101 0 0
IRON.				
Bars, Welsh, in London, per ton	7 10 0	7 10 0	7 10 0	7 10 0
Nail rods, do.	8 15 0	8 7 6	8 7 6	8 7 6
„ Stafford in London, do.	9 0 0	8 15 0	8 15 0	8 15 0
Bars, do.	9 0 0	8 15 0	8 15 0	8 15 0
Hoops, do.	9 15 0	9 15 0	9 15 0	9 15 0
Sheets, single, do.	10 10 0	10 7 6	10 7 6	10 7 6
Pig, No. 1, in Wales, do.	4 5 0	4 5 0	4 5 0	4 5 0
„ in Clyde, do.	3 15 9	3 18 6	3 17 6	3 16 6
LEAD.				
English pig, ord. soft, per ton	21 0 0	21 0 0	21 5 0	21 5 0
„ sheet, do.	21 10 0	21 10 0	21 10 0	21 10 0
„ red lead, do.	23 10 0	23 10 0	23 10 0	23 10 0
„ white, do.	27 0 0	27 0 0	27 0 0	27 0 0
Spanish, do.	20 0 0	20 0 0	20 0 0	20 2 6
BRASS.				
Sheets, per lb.	0 0 11	0 0 11	0 0 11	0 0 10¾
Wire, do.	0 0 10½	0 0 10½	0 0 10½	0 0 10¼
Tubes, do.	0 0 11¾	0 0 11¾	0 0 11¾	0 0 11½
FOREIGN STEEL.				
Swedish, in kegs (rolled)	13 0 0	13 0 0	13 0 0	13 0 0
„ (hammered)	15 0 0	15 0 0	15 0 0	15 0 0
English, Spring	18 0 0	19 0 0	19 0 0	19 0 0
Quicksilver, per bottle	8 0 0	8 0 0	8 0 0	8 0 0
TIN PLATES.				
IC Charcoal, 1st qu., per box	1 15 0	1 15 0	1 15 0	1 15 0
IX „ „ „	2 10 0	2 1 0	2 1 0	2 1 0
IC „ 2nd qua., „	1 13 0	1 13 0	1 13 0	1 13 0
IC Coke, per box	1 8 0	1 8 0	1 8 0	1 8 0
IX „ „	1 14 0	1 14 0	1 14 0	1 14 0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The Law on Compensation.—At the Westminster Sessions-house, on March 5th, before the High Bailiff (Mr. Scott Turner) and a jury, a question arose in a case, which occupied several hours, as to the compensation to be given in the claim "Berry *v.* The Metropolitan District Railway Company," for some premises in Wilton-road, opposite the Victoria station. Mr. Coleridge, Q.C. (Mr. Holl with him) appeared for the claimant, and Mr. Lloyd for the company. The claimant had obtained patents for kitchen ranges, and gas and warming improvements, and since the Victoria station his business had greatly increased, which he attributed to the advertisement given to his premises by the station. The premises were now required, and he declared that £3,000 would not pay him for his loss, and he would rather give £500 compensation to the railway to let him remain. He had other premises in the Victoria-road, and had been obliged to remove his manufacturing business from Wilton-road to Regent-street, Vauxhall-bridge-road. He employed nearly 100 hands, and his returns were last year about £15,000. He had a number of contracts from parishes and churches in the metropolis. Mr. Coleridge complained of the injury done to Mr. Berry by taking his premises, and claimed a handsome compensation; Mr. Lloyd considered the claim made as most excessive, and put the value of the premises and compensation at about £700. He had never seen a compensation case so "cooked" up before. The jury awarded £1,000.

Lees *v.* Whitely.—This case involved two questions—first, what was the effect of a bill of sale given to the plaintiff to secure payment for certain machinery; and, secondly, what, under the circumstances, was the effect of a notice given by him to the Northern Insurance Company, in which office the machinery was insured. The facts were these. The plaintiff supplied the machinery to Messrs. Whitely, Garsed, and Co., cotton spinners, at Rastrick, in Yorkshire, and they gave the bill of sale in question of their machinery, dated the 1st of November, 1861, in which there was a covenant to insure, which was performed for £3,800. The mill was destroyed by fire on the 16th of June, 1864, and on that day some of the partners consulted their solicitor, who advised them to execute an assignment to trustees for the benefit of their creditors under the Act of 1861. This was prepared and executed by them and the trustees to it, but went no further, not being executed by any creditor; and a person being in possession of the premises, this instrument was intrusted to him, but he was persuaded to give it up to a Mr. Farrar, a scuffle ensued, it was dropped, found by another person, and burnt. The plaintiff on the 24th of June gave notice by his solicitor to Benjamin Howe, agent for the insurance company, of his claim, but it was sworn on behalf of the defendants, that on the 23rd he had notice of the execution of the assignment. The firm became bankrupt in August, and the plaintiff then filed this bill, claiming the benefit of the policy, and to restrain the payment by the company without satisfaction of this demand. Mr. Osborne and Mr. Taylor appeared for the plaintiff, relying mainly on a case before Lord St. Leonards when Lord Chancellor. Mr. Osborne was heard in reply. Vice Chancellor Kindersley was of opinion that the Court could not imply a covenant, such as was to be found in the case before Lord St. Leonards, that, in default of insurance by the party who might be called mortgager, it might be effected by the mortgagee (the present plaintiff filling that character); for that would, in fact, be constructed a clause for the parties; therefore that portion of the case must fail; but, inasmuch as a different view might be taken of this point, his Honour would consider the other question. (His Honour referred to the facts.) It was clear that the notice to Mr. Howe was good notice; but then came the question whether the assignment of the 16th of June, 1864, was an act of bankruptcy, and whether the plaintiff had notice of it before the 24th of June. His Honour was of opinion that the assignment was an act of bankruptcy, because it was not carried out under the Act of 1861, and that the plaintiff had notice of it on the 23rd. June. Under these circumstances the bill must be dismissed with costs.

Re Tolhausen's Patent.—This was an application by Frederick Tolhausen to have the Great Seal affixed to letters patent for an invention claimed by him for the well-known firework called "Pharoah's serpents." It appeared that the petition for the patent was presented on the 7th of September last, and the sealing of it was opposed by Mr. Nottage, on behalf of the London Stereoscopic Company, on the ground that the alleged invention was not new, being a well-known chymical production, and also that the articles had been publicly sold by other persons before the application for the patent. These allegations were denied on behalf of the petitioner. Mr. Wilcock appeared for the petitioner; Mr. Macgregor *contra.* The Lord Chancellor said he regretted affixing the Great Seal to such a patent. As, however, it had not had been clearly proved that the invention claimed had been publicly exhibited before the presentation of the petition the usual rule of affixing the Great Seal must be followed. The validity of the patent might be afterwards disputed.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Engineers' Strike at Hull.—On Friday 2nd ult. the majority of the engineers of Hull, who for the past three weeks have been on strike, resumed their work. At a meeting of the Hull branch of the Amalgamated Society of Engineers held on the previous evening, at which delegates from the parent society were present, the men were strongly recommended to accept the terms which had been offered by the largest engineering firm in the town, Messrs. C. and W. Earle, iron shipbuilders, &c. The demand of the men was for an increase of 3s. per week, but Messrs. Earle offered to meet them by giving 2s. This the men refused to accept for upwards of a week, but at their last meeting, after considerable discussion, they resolved to resume work at all the shops in the town at the terms offered by Messrs. Earle.

The Middle Level.—It will be remembered that in the spring of 1862 a great flood took place in the Fens, occasioned by the failure of the middle-level outfall sluice near Lynn. A dam was constructed across the "drain" near the ruined sluice, under the direction of Mr. J. Hawkshaw, C.E., and some large siphons were directed to discharge the waters flowing through the "drain." In 1862, as well as in the two subsequent years, the rainfall at the spot was considerably below the average. Thus in 1862 it was 22·65in.; in 1863, 22·13in.; and in 1864, 16·13in. In 1865, however, it amounted to 27·12in., being nearly an inch in excess of the annual average of the thirteen years from 1852 to 1864, inclusive. During the first two months of the present year the rainfall has been 4·43in., being much in excess of the fall in the corresponding months of 1863, 1864, and 1865, yet at no time have the siphons or the level been overcharged with water. The siphons may thus be considered a success.

Board of Trade Returns.—The returns of the Board of Trade for the month and year ending Dec. 31st, have just been issued, from which we gather that the total declared value of exports for the month of the past year was £15,030,088 against £12,095,437 in 1864, and £14,354,400 in 1863. For the year the total was £165,862,402, for 1864 it was £160,449,053, and for 1863, £146,602,342. Amongst the principal changes in the exports during the month there is a decrease in firearms, and also in gunpowder. Of beer and ale there has again been a falling off. There has been an increase in coal and culm, and a considerable increase in cotton manufactures, the figures of the latter being 164,422,853 yards, against 131,876,650 yards in 1864. Linen yarns have increased, and linen manufactures show an increase from 17,582,407 yards to 23,909,209 yards. The exportation of machinery has decreased, but iron and steel have increased. Silk manufactures have improved in value from £99,999 to £103,389, and British spirits have declined from 135,992 gallons to 85,370 gallons. Of tea there was imported during the month of last year 24,865,692lbs.; in 1864 the importation was 25,034,844lbs. There has been a large decrease in tobacco, but an increase in wine. With regard to the Shipping Trade, it appears that in the month of Dec. last 3,853 vessels, 1,099,273 tonnage, employed in the Foreign Trade, were entered inwards, and 3,473 vessels, 1,010,575 tonnage, cleared outwards. In the corresponding month of 1864 the numbers were respectively 2,984 vessels, 810,871 tonnage, and 3,118 vessels, of 899,176 tonnage. In the Coasting Trade for the month of Dec. last 11,811 vessels, 1,673,246 tonnage, entered inwards, and 11,219 vessels, 1,501,476 tonnage, cleared outwards. In the month of Dec. 1864, the numbers were respectively 11,282 vessels, 1,444,819 tonnage, and 11,186 vessels, 1,451,306 tonnage. For the year last past 44,510 vessels, 12,164,253 tonnage, employed in the Foreign Trade, were

entered inward, and 48,181 vessels, 12,817,442 tonnage, cleared outward. In the year 1864, the numbers were respectively 42,108 vessels, 11,302,226 tonnage, and 47,255 vessels, 12,169,573 tonnage. In the Coasting Trade for the past year 147,520 vessels, 18,321,642 tonnage, entered inward, and 149,576 vessels, 18,003,577 tonnage cleared outward. In the year 1864, the numbers were respectively 148,498 vessels, 17,416,086 tonnage, and 153,559 vessels, 17,592,842 tonnage.

International Scale for Drawings.—Mr. Edwin Landseer writes to the *Builder*:—If plans and drawings published in this country and abroad could be drawn to a scale that would be universally useful, it would be of immense advantage. For this purpose it is only necessary that they be drawn to a scale capable of expression equally well both in, parts of feet and inches, and decimally; now full size, ½ full size, ¼ full size, ⅛ full size, and 1-16th of each of these respectively are such scales, of which the most useful are perhaps the 1-40th and (1-80th) full size, expressed in English, as 3-10ths (or 3-20ths) of an inch =1 foot in foreign decimal scales, as ·025 and ·0125 respectively.

Cure for Damp Walls.—The following is stated to be a good remedy for damp walls: Three quarters of a pound of mottled soap to one gallon of water. This composition to be laid over the brickwork steadily and carefully with a large flat brush, so as not to form a froth or lather on the surface. The wash to remain twenty-four hours, to become dry. Mix half a pound of alum with four gallons of water; leave it to stand for twenty-four hours, and then apply it in the same manner over the coating of soap. Let this be done in dry weather.

Great Springs.—There is a spring in the centre of the town of Huntsville, Alabama from which flows a stream of water large enough to float a thirty ton bateau. It is believed to be the largest spring in the world, and it is an object of great interest to the people of the neighbourhood and visitors. Another spring, near Florence, in the same State, throws out a body of water estimated at 17,000 cubic feet per minute.—*American Paper.*

The Mont Cenis Tunnel.—It appears from an official statement that the whole distance executed, or rather pierced, of the great Mont Cenis tunnel works during 1865 was 4,110 feet, or rather more than three-quarters of a mile.

Export of Iron and Steel.—The immense development of this trade can only be appreciated by casting a retrospective glance at its progress since 1850. In that year the exported value of the iron and steel was £5,350,056; in 1851, £5,830,370; in 1852, £6,684,276; in 1853, £10,845,422; in 1854, £11,674,675, in 1855, £9,465,642; in 1856, £12,966,109; in 1857, £13,603,337; in 1858, £11,197,072; in 1859, £12,314,437; in 1860, £12,154,997; in 1861, £10,326,646; in 1862, £11,365,150; in 1863, £13,150,936; in 1864, £13,310,484; and in 1865, £13,451,445. Comparing 1865 with 1850, we thus see an increase of £8,101, 389. It was in 1853 that the exports experienced their most rapid expansion, but even upon that year 1865 showed an advance of £2,606,023. If we analyse the exports of 1850 and 1865, we arrive at the following results:—

	1850.	1865.
Pig and puddled iron	£ 448,074	£1,591,364
Bar, angle, bolt and rod iron	2,801,043	2,213,123
Railway iron of all sorts		3,541,296
Iron wire	86.573	450,699
Cast iron	215,332	771,124
Hoops. sheet-iron, and boiler plates	1,454,410	1,597,604
Wrought iron of all sorts		2,494,371
Old iron for remanufacture	50,876	12,688
Unwrought steel	393,748	779,487
Total	£5,350,056	£13,451,445

There has thus been an immense advance in every department of the trade, with the exception of the comparatively insignificant item of old iron for remanufacture. Further, it will be seen that the total value of the exports was in 1865 larger than in any former year, excepting 1857.

Improvements in Gas-Engines.—In gas-engines, as at present arranged, it is common to fire the charges of mixed gas and air by means of electricity, but this is inconvenient, as it is found difficult to keep the batteries in working order. Mr. Hugh Smith, of Westbourne Park, therefore proposes as an improvement to fire the charges by means of vapour which burns spontaneously on coming in contact with air; the vapour he employs is that of the liquid phosphide of hydrogen; and he passes small pipes, which he calls explosion tubes, from the gas main to each end of the cylinder, and on these tubes are applied, just before the connection with the cylinder, bottles containing the liquid phosphide, so that the gas may pass over the liquid. When the cylinder is charged with gas and air, a tap on one of the explosion tubes is opened, and the gas, carrying with it the vapour of the phosphide, enters the cylinder, and the vapour there meeting with air, an explosion at once takes place, driving the piston along the cylinder, and in this manner the piston is driven from end to end of the cylinder. This method of firing the charges is applicable whatever be the form of the combustion chamber, whether it be, as assumed, in the foregoing description, a cylinder with a piston working within it, or of other form and construction.

Stealing Gas.—At the Aylesbury assizes, a rather curious case has been tried. Mr. G. W. Harley, a builder of Slough, was indicted for stealing gas from the Slough Gas and Coke Company. It had been observed all last year that Mr. Harley's meter registered very much less gas as having been consumed than in the corresponding quarter of the previous year; but on being examined at Christmas, it appeared that no gas had been burnt since Michaelmas, though it was evident to everybody in the neighbourhood that Mr. Harley had been consuming it as usual. It was then found that a bit of solder had been dexterously inserted in the meter, so as to prevent the registration. Mr. Harley did not deny that the meter had been tampered with, but said simply that he knew nothing about it, and the judge observed that there was nothing whatever to show that he did, except the fact that he was the only person that could have benefitted by the fraud. His lordship, therefore, withdrew the case from the jury. There have been serious disputes for some time past between the Slough Gas Company and some of their customers; and it was asserted by counsel for the defence, that if the case had gone on it would have been proved that several other meters had been tampered with in the same way.

NAVAL ENGINEERING.

Iron-cased Double Screw Turret-ships.—Messrs. Laird Brothers have just completed another iron-cased turret-ship for seagoing and coast defences, named the *Bellona*. She is 1,340 tons, and is fully protected by armour-plates 4½ inches thick, tapering slightly at the ends, is fitted with double screws, and rigged as a barque, and has two turrets on the principle of Captain Cowper Coles, fitted for four 150-pounder Whitworth rifled guns, two in each turret. The Bellona made the run from Liverpool to Holyhead, a distance of about 60 nautical miles, in five hours and a half; and has since arrived at Madeira in six days from Liverpool. We are also informed that the *Minerva*, a double-screw turret-ship of 1,000 tons and 140-horse power, built by Messrs. Laird, made the passage from Liverpool to Rio de Janeiro in 30 days, including all stoppages, which gives a speed of nearly nine knots per hour, and proved herself during the voyage an excellent seaboat under all circumstances, although drawing only eight feet. The performances of these vessels on their trial trips and at sea prove the advantages of the double-screw system for turret-ships of light draught of water.—

New War Steamer for Japan.—The screw steam-frigate *Kajomar*, built by C. Gips and Son, of Dordt, returned there from Helvoet on Monday, where she had been to receive her boilers and iron masts. She has been built for the Japan Government, and her dimensions are:—Length, 250 feet; breadth, 48 feet; depth, 32 feet; 1,200 tons measurement, and 400-horse power; and is the largest ship that has been built in Dordt.

A New Torpedo.—The *Gazette de Midi* states that a new torpedo of a more destructive kind than any hitherto invented has just been tried in the Dockyard of Castigneau, Toulon, with complete success. The *Vauban* ship-of-war, attacked by a boat twenty feet long, supplied with a spur armed with a fulminating torpedo, was lifted three feet out of the water and instantly sunk in consequence of an enormous hole in her keel caused by the torpedo. The success was the more remarkable as the charge of powder was only six pounds, but it is of a new invention, and more powerful than any yet tried.

The "Favourite," 10, iron-cased screw corvette, Capt. F. H. Short, was taken for her final trial before leaving Sheerness for foreign service on Friday, 16th ult., to the Maplin Sands. She is fitted with a pair of horizontal direct-acting engines, 64in cylinder, 32in. stroke, 400-horse power, of the usual description, supplied by Messrs. Humphrys and Tennant. The trial was most satisfactory. It commenced at nine o'clock, when six runs were made at the measured mile, at full-boiler power, giving the following results:—Mean speed, 11·825 knots per hour; pressure of steam. 20lb.; vacuum, 25in.; revolutions of engines, maximum 70, mean 68. At half-boiler power two runs were made, giving a mean speed of 9.393; revolutions of engines, 56; vacuum, 25in.; pressure of steam, 20lb. The circle was turned at half-boiler power, with helm to starboard 25 degs., in 6 min. 20 sec., the diameter of the circle being 339 yards, and with helm to starboard 20 degs., in 5 min. 21 secs., the diameter of the circle being 410 yards. At the close of the trial the engines were stopped from full speed in 11 sec., started ahead in 6 sec., stopped in 7 sec., and started astern in 8 sec. The draught of water during the trial was 19ft. 7in. forward, and 22ft. 7in. aft. There was a force of wind from 3 to 4 S.W., and the sea was smooth. The engines worked most admirably; there were no hot bearings, and an entire absence of priming. The *Favourite* is fully rigged, having all her sea stores, provisions, and about 300 tons of coals on board. Her armament consists of eight 6½-ton Armstrong muzzle-loading guns, and two 64-pounders, the latter carried on her bow and stern. The results of the present trial give about 1-10th of a mile more than on any previous trial, although the vessel draws two feet more water. It is understood at present that the *Favourite* will leave Sheerness shortly for the Pacific.

The "Tor."—Messrs. Laird Brothers have just completed a vessel on the double screw system, named the *Tor*, of 680 tons, which is intended to carry cargo and passengers on a light draught of water, and is rigged as a topsail schooner. The engines are two separate pair of seventy horse-power, each direct acting, and driving two screws, one under each quarter, and working independently of each other, so that one may be worked ahead and the other astern, at a moment's notice, for the purpose of turning the vessel in narrow channels. The *Tor* was undocked on Tuesday last for trial of her machinery before starting for Southampton; and although the day was unfavourable, with a strong breeze and considerable sea, the speed attained was 11¾ knots, with 102 to 104 revolutions of the engines, and it is expected under more favourable conditions that this will be increased to 12½ knots. An experiment was made to test the speed that could be obtained with one pair of engines, the port engines being worked at full power, and the steam shut off from the starboard engines, and it was found that a speed of nearly nine knots was obtained, the shafting of the starboard engines being revolved by the action of the water on the screw, By this arrangement one half the engine power may be used with a comparatively small reduction in speed, but a great economy in fuel, more particularly on long voyages and when under sail.

STEAM SHIPPING.

Shipbuilding on the Clyde.—There is at present considerable activity in the various building yards on the river, and though, so far as the amount of tonnage is concerned, the shipping launched during the month of February last compares unfavourably with that of the same month of the two previous years, the orders on hand are both numerous and heavy, and keep the trade sufficiently brisk. Last February the number of vessels launched was 13, the aggregate tonnage amounting to 6,300 tons. In February, 1865, the same number of vessels were launched, but the tonnage amounted to 9,870 tons, while in February, 1864, there were 14 vessels launched, of 15,104 tons, being more than double the tonnage launched during the month just closed. Among the larger vessels launched during February are the following:—The *Ajax*, screw steamer, 2,400 tons, 300 horse-power, built by Messrs. Scott for Mr. Holt, of Liverpool, for the Liverpool and China trade; the *Villa del Salto*, paddle steamer, 600 tons, 150 horse-power, built by Messrs. J. and G. Thomson, for the Nueva Companea Sultena, for the Montevideo trade; the *Cosmo*, 400 tons, 40 horse-power, by Messrs. A. and J. Inglis, for the River Plate trade; the *Kittiwake*, paddle steamer, 380 tons and 80 horse-power, for the North British Railway Company, for the Liverpool and Silloth trade; the *Gleniffer*, 800 tons, iron ship, built by Messrs. Barclay, Curl, and Co., for Messrs. J. and A. Allan, Glasgow, for the Montreal trade; the *Misero*, 540 tons, iron ship, built by Messrs. A. Stephens and Sons, for Mr. Hainsworth, Liverpool, for the copper ore trade. Besides the above, two or three river steamers, a steam dredge, and two iron lighters have been launched. During the past month Messrs. Caird and Co., of Greenock, have launched a paddle named the *Herald*, intended for the Glasgow, Greenock and Campbelton line. The dimensions of the *Herald* are:—Length, 200ft.; breadth, 22ft 6in.; depth, 11ft. She will have oscillating engines of 150 horse-power. Messrs. A. and J. Inglis, of Pointhouse, have launched a screw of 400 tons named the *Cosmos*. Her dimensions are 145ft. keel and forerake, 24ft. 4in. beam, and 8ft. depth. Her machinery consists of two pairs of direct-acting engines of 20 horse power each, which act independently of each other. She has been constructed expressly for the River Plate traffic, where only light draught vessels are available. The draught of the *Cosmos* when fully loaded will not exceed 4ft. Messrs. J. and G. Thomson have launched the *Weasel*, a screw of 700 tons and 150 horse power, intended for Messrs. Burns' service, and to run between Belfast and Glasgow. The *Weasel* has been built to replace the *Beagle*, run down in the Channel at the close of last year. Messrs. W. Simons and Co., of the London Works, Renfrew, have launched a large and powerful dredger for the River Clyde trustees.

LAUNCHES.

The "Panama."—On Saturday, the 17th ult., there was launched from the building-yard of Messrs. Randolph, Elder, and Co., Fairfield, Govan, a paddle steamship of 2,008 tons B.M., named the *Panama*. Her dimensions are:—260ft. long, 40ft. beam, and 18ft. 6in. depth, moulded. The machinery is by the same firm, on their double cylinder principle, and of 400 horse-power. She has been constructed for the Pacific Steam Navigation Company, for the mail and passenger service on the Pacific Coast of South America.

Launch of the "Surat."—An iron screw steamer, named the *Surat*, built for the Peninsular and Oriental Company, was launched from Messrs. C. A. Day and Co.'s shipbuilding yard at Northam, Southampton, on the 17th ult. Her leading dimensions are as follows:—Length between perpendiculars, 318ft. 5in.; length over all, 350ft. 6in.; beam, 41ft. 5in.; depth of hold, 33ft.; tonnage, builders' measurement, 2,666. She will be fitted with engines of 500-horse power, cylinders (which are steam-jacketed and

provided with expansion valve) 80-in. diameter and 3ft. 6in. stroke, and superheater and boilers on Lamb and Summers's plan. The screw propeller has four blades and a diameter of 18ft., with 24ft. pitch. The *Surat* is built of iron, with steel plates to form her top sides, thus saving about 60 tons of top weight, and at the same time obtaining a greater amount of strength. The spar and main decks are of teak, and she will be brig-rigged, the mast being of iron. There is great height between decks, and her ports are higher out of water than most other vessels carry them, which will enable passengers to keep the ports open in ordinary weather, thus insuring a constant supply of fresh air, so necessary for health and comfort, especially in an Indian climate. The side ports are large, and in addition the most ample means for ventilation are provided throughout the ship. She will have accommodation for about 200 passengers.

The Attempted Launch of the "Northumberland."—On Saturday 17 ult. the launch of the *Northumberland* ironclad was appointed to take place from the yard of the Millwall Ironworks and Shipbuilding Company. This vessel is the third of the trio of the *Minotaur* class that has been constructed hitherto, the two others being the *Minotaur* and *Agincourt*. She is, like her sister iron clads of 6,621 tons, 400 feet long × 59 ft. 3" beam, and plated from stem to stern with 5½in. armour, instead of 4½ in., on a backing of 9 in. of teak, instead of 18 in. as in the vessels of the *Warrior* class. The power of the engines has been increased from 1,250 to 1,350 HP, and a speed of 16 knots per hour is promised by the makers, Messrs. John Penn and Son, Greenwich. We regret to state that the attempt to launch this vessel, on the 17 ult., proved a complete failure. After going half way down the launching ways she slowly came to a standstill, and in spite of every effort that was made, she remained half in the water and half out of it. Contrary to the general practice, it was attempted to launch the *Northumberland* nearly finished; no more than 250 tons of plates remained to be fastened. This accounts for the difficulty encountered in the present instance; the *Agincourt* and *Minotaur* had been launched with the utmost ease, because the latter was sent afloat without her armour being fixed, and the former was built in a wet dock. At the hour of going to press, not the slightest change had taken place in the position of the *Northumberland* and nothing further was proposed to be attempted until the second week of April, when all the efforts to be made would be assisted by the high spring tides.

TELEGRAPHIC ENGINEERING.

A Telegraph Line Six Thousand Miles Long.—The telegraph has lately been extended far up Fraser River *en route* for Russia, according to the *Panama Star*, and is now in working order from New York *viâ* San Francisco to a point 400 miles above New Westminster on Fraser River, making in round numbers about 6,000 miles.

RAILWAYS.

Pontifical Railways.—At the close of the present year it is expected that the Roman Railway Company will have 1,060 miles in operation, commencing at La Spezzia and passing *viâ* Leghorn, Pisa, Florence, Rome, Naples, and Ancona.

RAILWAY ACCIDENTS.

Fall of another Railway Viaduct near Huddersfield.—Part of the Whitaker Mill viaduct, on the branch line from Huddersfield to Kirkburton, has given way, and stopped up the canal. It was of brick and composed of seven arches, each 64 feet span and 21 feet 4 in. rise, with piers 8 feet 6 in. thick, and on a curve with a radius of 22 chains. The centres were removed from the two arches about two months ago, and afterwards a slight subsidence was noticed in the second arch; but it was not considered dangerous. The frost following the wet weather has had the effect of breaking it down, bringing with it the first arch. The *débris* filled up the canal. The rebuilding of the arches will take some months.

Compensation for Railway Accidents.—The Metropolitan Railway Company have presented to Parliament a Bill asking for additional powers, and containing a clause limiting the company's liability for injury by accident on the railway to cases in which notice of the claim is given to the company within two months. The Board of Trade suggest that if such an alteration of the law be made, it would be more convenient that it should be by a general Bill than by special Acts of railway companies creating exceptional immunities in their favour. One or two companies are also applying this Session for Bills which if passed as presented will create an exception in their favour in regard to liability to make compensation for injuries to third-class passengers. The liability has been limited to £100 in relation to passengers by certain morning and evening trains which various companies are compelled to run at extremely low fares for the accommodation of the working classes; one company now desires to have this limited liability to third-class passengers applied to all its Parliamentary trains.

DOCKS, HARBOURS, BRIDGES.

Opening of a New Dock at Birkenhead.—The new intermediate dock at Birkenhead has been formally inspected by the Mersey Dock Board, and opened for commercial purposes. Its area embraces seven acres and a half, and it has three entrances from the river. The work has been completed by Mr. Lyster, the present dock engineer, from the designs of Mr. John Hartley, late engineer to the board.

Southampton Docks.—There has been an astonishing increase in the revenue of Southampton Docks during the last 22 years. This will be seen from the annexed recapitulation of the receipts in alternate years:—1844, £4,018; 1846, £13,203; 1848, £19,534; £1850, £20,614; 1852, £30,302; 1854, £43,502; 1856, £54.180; 1858, £48,800; 1860, £54,558; 1852, £58,120; 1864, £58,358. In 1865 the revenue further increased to £62,450.

MINES, METALLURGY, &c.

Conversion of Cast Iron into Cast Steel.—A new process for the rapid conversion of every mass of cast iron into cast steel, homogeneous and of great purity, has been thus described by Mr. Galy-Cazalat, in a memoir addressed to the Academy of Sciences:—"Cast steel is a combination of iron with some thousand parts of carbon, and cast iron consists of iron and about 5 per cent. of carbon, alloyed with silicium, sulphur, and other metalloids. Hence, it results that steel is obtained by causing currents of gas containing oxygen, and particularly superheated steam, to pass through a bath of cast iron in fusion. In traversing the mass of molten metal the steam is decomposed; its oxygen burns the carbon and oxidises the iron, while its hydrogen takes up from the metal its sulphur, phosphorus, and other metalloids, which would render the steel brittle. In proportion as the cast iron loses its carbon its temperature rises rapidly beyond the melting point of the steel. When the colour of the flames, which rise from all parts of the bath, indicates a suitable degree of decarburation, the steel is then run into the mould. This system, the most simple and least costly, of fabricating steel in large masses, was imagined by Mr. Galy-Cazalat, and experimented upon at the Palais de l'Industrie, during the Universal Exhibition of 1855. Since that period he has operated on a large scale, either in a crucible containing 5 tons of cast iron, or in a reverberatory furnace, of improved construction, the flame of which produces the steam necessary for the decarburation. Unfortunately, the characters indicative of the precise transformation of the cast iron into steel being uncertain, he obtained sometimes pure iron without carbon, and at other times an alloy of oxide of iron and too much carburated steel, according as he allowed too much or too little steam to pass through. This inconvenience was common to his process and that of Bessemer, who, in 1856, took out a patent for making steel by causing to pass through the cast iron, in fusion, currents of air compressed at heavy expense by machines thirty times more costly than the reverberatory furnace, which produces the steam. Lastly, for the last three years the inconvenience arising from the incertitude as to the number of minutes after which the decarburating currents of air, steam, or rather oxygen, must be stopped has no longer existed; the manufacture is regular, and we obtain always common steel by decarburating *completely* the mass of melted cast iron, either by air or by steam, and then adding 10 per cent. of spathic cast iron, to restore to the iron the carbon that it requires to form steel. This steel, actually used for railway bars, requires, however, to be recast so as to become homogeneous and of superior quality, and this second operation, which is carried on in crucibles containing 44 lbs., doubles at least the cost of homogeneous cast steel."

New Method of Rolling Iron.—A recent invention of a new method of rolling iron is one of the most important yet made for the working of this useful metal. It consists of a process for rolling into irregular shapes, by which chequered surfaces, projections, and depressions can be obtained with the same facility as plain surfaces have heretofore been produced. This result is accomplished by means of adjustable discs, of any desirable pattern, placed upon ordinary rollers, which leave upon the bars drawn through them the impress of the figures which they bear. Instead of solid rolls turned with grooves and peripheries in the ordinary manner, the inventor uses the cast or wrought iron spindles, on which are slipped cast iron or steel rings or discs, forming grooves or peripheries, corresponding to those of ordinary rolls, and susceptible of an almost infinite variety of combinations. The spindles are allowed to project beyond the housings of one side, thus giving an opportunity for placing upon them every variety of pattern discs, and requiring but a few minutes to effect any desired change. Thus one set of spindles, with their accompanying discs, will do the work of a large number of rolls constructed in the old solid form; and fractures of grooves on peripheries can be easily repaired without the loss of the remaining portion of the rolls—an advantage which will be readily acknowledged by all the iron workers. Usual forms can also be made quickly and cheaply, since it is only necessary to cut the simple and comparatively inexpensive discs for them; whereas by the old method entirely new rollers must be made for each new form demanded, and it is impossible to obtain irregular surfaces.—*American Paper.*

Copper Rolling in the United States.—From the report of the eighth census, it appears that there are seven establishments in the United States for copper rolling. These establishments employ 413 hands, and have a capital invested of 2,470,000 dollars. The cost of material consumed by them is valued at 2,537,000 dollars—the cost of labour at 157,080 dollars; and the annual value for the year ending 1st June, 3,198,767 dollars.

Welsh Gold.—Five mines in Merionethshire have been producing gold during 1864; 2,336 tons of quartz have been crushed, and 2,887 ozs. of gold obtained, the value of which was £9,991. This is in excess of the quantity obtained in 1863, which was only 552ozs.; but it is considerably less than the production of 1862, when 5,299ozs. were extracted, having the value of £20,390.

Silver Mining in Nevada, U.S.—The yield of the Gould and Curry Mine for the quarter ending Nov. 27th, 1865, was 12,948 tons, valued at 38·14 dollars per ton, and amounting to 493,836·79 dollars. The yield of the Chollar Potosi Mine for the same period was 12,509½ tons of ore, valued at 30·75 3-5 dollars per ton, amounting to 384,742·10 dollars. The Savage yielded 8,036 tons, valued at 39 dollars per ton, and amounting to 313,404 dollars. The Ophir yielded 3,000 tons, valued at 18·33½ dollars per ton, and amounting to 32,119·81 dollars. Total number of tons extracted 38,285½, amounting to 1,279,101·53 dollars, from those five mines. That is not so bad; but just wait till they get to taking out ore from the big shafts now sinking, and then we can talk about a yield: 180ozs. of retorted amalgam, worth 3,000 dollars, was recently extracted from 65 tons of rock out of the Lucky Mine, of Grass Valley; average, 45 dollars to the ton.—*San Francisco Mining Press.*

Copper Mining in South Australia.—The *Wallaroo Times* says: Mining, which has always, since the discovery of copper at the Wallaroo Mines, flourished in Yorke's Peninsula, is now in a more prosperous condition than ever. There is scarcely a mine at work here but what is progressing in a greater or less degree, and we are glad to perceive that the secondary mines are giving promise of paying at no very distant period. We believe, at their present rate of yield, the Yelta and Karkarilla must be more than paying their working expenses, and probably the New Cornwall Mine must be doing the same. The quantity of ore shipped from this port during November was 2,800 tons, of which the Moonta Mine alone furnished above 2,300. Nearly the whole of the ore shipped, or at least 2,700 tons of it, would find its way to Swansea; and as a considerable quantity of it was of high percentage, we think we shall be within the mark in valuing the total quantity shipped at £12 per ton, or £33,600. Besides this the shipments of copper amounted to 371 tons during November, and valuing it at £88 per ton, we have £32,648,—nearly as much in value as the ore. This shows our total shipments of mineral produce to amount to £66,248 for the present month. Nor, do we believe this to be a very exceptional case as to the amount of one month's return, although it may be as to quantity shipped. We believe we are within the mark in estimating the regular average monthly returns of ore from all the Peninsula mines at 4,200 tons, worth on an average at least 17 per cent. of pure copper. The value of this ore, at £12 per ton, is £50,400 per month, or £604,800 in a year. When we add to this the exports of ore from the Burra, Bremer, Kanmantoo, Kapunda, Yudanamutana, Blinman, and other copper mines, besides those of silver-lead from the Talisker and other mines in the South, and the various ores of bismuth, silver-lead, and copper from the other side of the Gulf, the total mineral exports of the colony will represent a value for the present year probably not far short of three-quarters of a million sterling; or, at any rate, the exports for the last six months of the year will be found to be nearly in that ratio. At the present rate of production, unless the price of copper should fall considerably, next year's exports are likely to be still larger. This will, we believe, place the value of our mineral productions at the top of the list of exports, above even cereals and wool, and in the position which three or four years ago we expected they would ere long occupy. If we go on at the same rate as we have done during the past three years, the produce of our copper ores will soon equal in value those of England, which in the year 1864-5 only amounted to £1,100,554 as the produce of 222 mines. The quantity of copper from all these mines was 210,947 tons in the year, while that from the Moonta and Wallaroo mines alone is now at the rate of about 45,000 tons per annum, or more than one-fifth of the total quantity raised in England. But our ores are so much richer that a far larger quantity of copper is made from them than from the English ores, so that the present produce of the Moonta and Wallaroo mines is nearly half as much as that of 222 mines of England!

Mining in Utah.—The *Vedette*, of Salt City, says: This territory presents one of the widest and most lucrative fields for capital, energy, science and labour. The hardy adventurers who discovered the rich mines of Rush Valley and Bingham Cañon, who are developing the Cottonwood and Western districts, and those who have explored and opened up the marvellous riches of Meadow Valley and Pah-Ranagat regions, on the south-western verge of the territory, now begin to reap the reward of their perseverance, energy, and faith in the assurance that capital will soon flow in upon them to give value to these mines, and remunerate itself in early and practical development. During the past year representatives of Eastern and European companies have visited

Utah, accompanied by gentlemen of scientific acquirements. These gentlemen have passed through several mining districts, carefully examined the ores and the mines, and taken extensive notes on which to base their reports. They have expressed the highest encomiums on the Utah mines, even after having traversed the world-wide silver regions of Nevada, Idaho, and Montana. Of those whose opinions are entitled to the greatest weight, may be mentioned Professor Eaton of New York, and Professor Pritchett of England, both gentlemen of scientific and chemical attainments and conversant with practical mining. One and all concur that with the facilities to be found here in close proximity to the silver mines, wood, water, coal, fire clay, iron, and copper, in connection with the character of the ores and the practability of separating the baser from the precious metals, the mines of Utah present the most desirable and promising field for the investment of capital, enterprise and labour. These ores are mainly argentiferous galena, and their reduction and separation can be accomplished without the enormous expenditure for mills and heavy crushing machines required in most other countries. All that is absolutely necessary to transmute the ores into glittering silver are furnaces for melting them down. At Stockton in Rush Valley, but forty-five miles from Salt City, the crudest furnaces and the most simple devices have sufficed to prove the tractability of the ores and the facility and cheapness of their separation. One or two companies of Eastern capitalists have located there, purchased extensive interests in the mines, and are engaged in putting up the necessary furnaces and apparatus, on a more extended scale than the original locators were able to do. In the early spring we are promised the most desirable results, and preparations are being made to develop the Pah-Ranagat and other districts by capitalists from the East as well as by our own citizens.

COAL-FIELDS OF RHENISH PRUSSIA.—It is rumoured that the celebrated Saarbruck Coal Mines, the nett profits of which amount to 2,000,000 thalers (£300,000) per annum, and may be doubled without the coal being exhausted for centuries to come, are about to be sold or leased to a French Company by the Prussian Government. The Saarbruck chamber of commerce have addressed the latter, asking whether there is any foundation to that rumour. No reply has as yet been given.

BOILER EXPLOSIONS.

PREVENTION OF STEAM BOILER EXPLOSIONS.—A series of interesting and imporrtant experiments in connection with steam boilers has been made by Mr. Norman Wiard, of New York. He inserted a number of thermometers into a boiler (which subsequently exploded) for the purpose of ascertaining the differences of temperature, if any existed, in the interior of the boiler. He found—Below in the water-line, 276°; in the steam, from 395° to 500°; 12 in. above the rupture, 500; 12 in. below the rupture, 269°. The surface of the water in the boiler oscillated (the boilers were in use in the steamer *St. John*) up and down 6 in., alternately heating the plate by exposure to the hot steam at 500°, and cooling it by contact with the water at 269°. It appears that the experiments have already created a great sensation among boiler makers and engineers, and a large number of well-known mechanics have examined the experiment for themselves, and expressed their surprise at the discovery, it being considered that the certain effect of the sudden change of 231° constantly occurring must be to permanently weaken, by repeated expansion and contraction, the plates of the boiler. These results are exactly opposed to those stated by Mr. Charles Wye Williams, who concluded, from experiments made at a low range of temperature, that after both the steam and water had reached 212° temperature, there was thenceforward no perceptible variation of heat between the steam and water areas in the boiler. He states that when both thermometers indicated a temperature of 218°, they would both fall simultaneously to 212° on the steam being allowed to escape.

SINGULAR CAUSE.—The telegraph announces a tremendous explosion of a locomotive boiler, at Terre Haute (Indiana), which was very destructive, throwing off the roof of the building, spreading the wall, and scattering freight, timber, brick and mortar, books and papers, in all directions. The most singular part of the announcement, however, is the cause which has been assigned for the catastrophe—"the extreme cold weather."

GAS SUPPLY.

THE FOLKESTONE Gas and Coke Company have declared a dividend at the rate of 10 per cent. per annum for the last half-year. Plans for new works have been prepared and tenders sent in.

THE CHESTER Gas Company have yielded so far by reducing the price of their gas from 4s. 6d. to 4s., but have refused to allow the 5 per cent. discount formerly given. Doubtless, when the Chester Gas Company reap the benefit to themselves of their forced reduction of price, they will be as thankless as others have been to those who have forced them to do what turns out to be for the benefit of the company no less than of the public, as in nine cases out of ten such forced reductions have been.

THE CARDIFF Gas-light and Coke Company have declared a dividend at the rate of 10 per cent. per annum for the last half-year on their old shares, and of 8 per cent. on new shares.

GAS STATISTICS.—In the House of Commons, a motion of Captain Gridley has been agreed to for a return from every gas company established by Act of Parliament in the United Kingdom, stating the several Acts under which established, the rates per 1,000 cubic feet at which such company or corporation had supplied gas in the years 1864 and 1865, and the average price of the coal used by the company in each year for the same period; also stating the amount of fixed capital invested by each gas company, and the rate per cent. of dividend to the shareholders or proprietors on their shares in each year (in continuation of Parliamentary Paper, No. 55, of Session 1865).

APPLIED CHEMISTRY.

CHROME YELLOW.—Mr. Dullo, in the *Deutsche Illustrirte Gewerbezeitung*, says—The preparation of a good chrome yellow is rather difficult, and frequently the product obtained, instead of preserving its light canary colour, becomes gradually orange coloured. This change of tint greatly damages the beauty of the colour, and consequently its value; it may, however, be altogether avoided, by leaving the precipitate of chromate of lead for some time in darkness. The reason why this orange tint is so easily produced is, that whilst the neutral chromate of lead which constitutes chrome yellow is of a light canary colour, the basic salt, commonly called chrome red, is orange coloured; but the former, like nearly every salt of lead, has a certain tendency to pass to the state of basic salt, whence arises a change of colour, more or less marked, which is especially produced when acetate of lead has been used to prepare the chrome yellow. This alteration is less to be feared when nitrate of lead is employed, and when the solution of this salt poured into that of chromate of potash is rather less in quantity. Nitrate of lead is perhaps too expensive for every case, but it gives a purer, and, above all, a less orange-coloured product than the acetate.

PREPARATION OF ALUMINA FOR COLOURS.—Dullo obtains pure alumina in a very fine state of division by dissolving one kilog. of alum in five litres of water, adding five grammes of sulphate of copper. He then throws into the solution about 2·50 grammes of zinc-cuttings, and places the whole in a properly heated place for two days. The copper is first precipitated on the zinc, and a voltaic battery is formed. By continued action the zinc is dissolved, and the alumina is gradually deposited. The reaction is ended when the solution gives no precipitate with excess of ammonia. If the action is prolonged, oxide of iron may be thrown down, which will give the alumina a yellow colour. Should this happen, the iron may be removed by boiling a few moments with very dilute sulphuric acid.

CARBOLIC ACID.—Herr Muller says in the *Zeitschrift für Chemie und Pharmacie*: Phenic acid or phenylic alcohol is usually accompanied by its congeners, xylic and cresylic alcohols, which adhere to it with great tenacity, and give it the property of becoming brown in contact with the air. For its purification the author has recourse to a partial neutralisation, and afterwards to the fractional distillation of the product. The crude tar cedes to soda or lime water a mixture of the matters before mentioned, as well as naphthaline, which is soluble in concentrated solutions of the alkaline phenates. Water is added to this until it ceases to cause a precipitate, when the liquid is exposed in wide vessels, to facilitate the formation of the brown bodies and their deposit. After filtering, the approximative quantity of organic matter held in solution is determined; formed principally of phenic acid and its congeners, which are easily displaced by acids. The phenic acid is always the last to separate, so that it is easy to disembarrass it of its associated matter and brown oxidised products by adding carefully the proportion of acid determined by calculation, so as to precipitate at first only these matters, and by means of several trials it is easy to arrive at the proper point to stop, so as to retain the phenate nearly pure. The acid is now separated and rectified and soon crystallysis. As a little water prevents its crystallisation, the author removes it by passing a current of dry air over the phenic acid nearly boiling. The crystallisation is facilitated by cooling, or by the introduction into it of a small quantity of the crystallised acid. The author insists on the necessity of exposing the alkaline solution of the acid for a long time to favour the resinification and deposition of the brown matters; phenic acid is always impure when it is coloured. It should be quite pure when employed to make picric acid, because the impurities waste the nitric acid. Phenic acid often contains a fetid substance, which appears to be a sulphuretted compound of phenyl or cresyle. It is removed by rectification from oxide of lead.

ANTOZONE.—Herr Osann writes to the *Journal für praktische Chemie*.—The vapours accompanying the slow combustion of phosphorus have, by certain chemists, been regarded as phosphorus acid. M. Schoenbein considers them to be nitrate of ammonia; while M. Meissner, again, sees in them antozone. With a view of clearing up this point, the author has passed these vapours into solutions of ammoniacal nitrate of silver and alkaline solutions of oxide of lead. In the first place a black precipitate was obtained; this precipitate contained, on an average, 97·28 of silver to 2·72 of oxygen, which composition corresponds to the formula Ag_3O. The author at first thought that the oxygen contained in this precipitate was ozone, which, having more powerful affinities than ordinary oxygen, had displaced the latter in the oxide of silver, but the oxidising nature of ozone has caused him rather to attribute the formation of this body to a deoxidising action such as produces antozone. He afterwards passed the same vapours; first into an alkaline solution of pyrogallic acid, to retain the ozone; then partly into one of Woolf's bottles containing a little water; partly into an ammoniacal solution of nitrate of silver; in this case the same precipitate was obtained, though all the ozone must have been absorbed by the pyrogallic acid. The water in Woolf's bottle, which had remained in contact with the vapours from the phosphorus, was shaken with blued tincture of guaiacum, which immediately lost its colour. The same thing happened with nitrite of ammonia and oxygenated water, but much more slowly with the latter, though it was highly concentrated. Hence the author does not hesitate to say that in his experiment the decoloration was due to nitrite of ammonia, and, consequently, he attributes the vapours produced during the slow combustion of phosphorus to the formation of this body.

PYROPHOSPHATE OF IRON AND SODA.—Mix a solution of six parts of pyrophosphat of soda in 120 parts of water, with a mixture of 13 parts of perchloride of iron solution sp. gr. 1·44, and 78 parts of water. Well wash the precipitate to remove all the chloride of sodium. Dissolve the precipitate in a solution of 4 parts of $2NaO, PO_5$ in 36 parts of hot water; evaporate until a pelliele forms, and scale in the ordinary way, drying the plates at the ordinary temperature. The concentrated solution may also be precipitated with four times its volume of strong alcohol (95 per cent.). In this way a thick, cheesy, transparent precipitate is obtained. Pyrophosphate of iron and soda forms hard, yellowish, transparent scales. Dried in the air the composition answer to the formula—$2(2NaOPO_5) + (2Fe_2O_3, 3PO_5) \times 20HO$.

NEW TEST FOR POTASH.—Bitartrate of soda is recommended by M. Plun Rett as a precipitant of potash. The solution is made by dissolving tartaric acid in water, dividing the solution into two parts, saturating one of these with carbonate of soda, and then mixing the remaining acid solution. The liquor containing potash must be slightly acidulated before the reagent is added.

THALLIUM.—With hyposulphite of soda salts of thallium form a white precipitate soluble in boiling water, as well as in an excess of hot hyposulphite; in the latter case a double hyposulphite is produced. As is well known, chlorides form a white precipitate with these salts, which turns violet when exposed to light, like chloride of silver. With alkaline iodides they give an orange precipitate, which turns yellow. The precipitate forms less readily in acid liquids. It is less soluble in alcohol than in water, and as Nikles has shown, less soluble in iodide of potassium. Bichloride of platinum gives a yellow precipitate which passes easily through the filter. At 16° C. 1 part dissolves in about 1·6000 parts of water.

ICE-MAKING.—Signor Toselli has constructed an ice-making machine for household use, in which compressed steam replaces the ammonia or the sulphurous acid gas employed in the machines which are already familiar to our readers. A small one will make 11lbs. of ice an hour at a cost of from ⅛d. to ¼d. per lb. The plan adopted is briefly as follows:—In one cylinder a solution of common salt is placed, and to this another cylinder is adapted. The saline solution is then heated (not above 212°) and the steam is passed into the second cylinder. After about an hour a tap between the two cylinders is turned, and the one containing the compressed steam is placed in a vessel of cold water.

NEW FILTER.—A new form of filter has been devised by the Appareteur of the College of France. It is made by placing in a tank of impure water a vessel so arranged that a sponge which it contains shall lap over its edge and dip into the water of the tank. The sponge gradually sucks up and purifies the water in the reservoir, and allows it to drop into the smaller vessel or receiver, from which it may be drawn off by a tube. By placing a few lumps of charcoal in the bottom of the receiver, filtration of the most perfect kind is effected.

PRESERVATION OF FRESCOES BY MEANS OF PARAFFIN.—Vohl coats the picture with a saturated solution of paraffin in benzole, and when the solvent has evaporated, washes the surface with a very soft brush. Paraffin has the advantage over other greasy matters of not becoming coloured by time.

GALACTOZYME.—Galactozyme, or galozyme, is the result of the fermentation of milk by means of yeast, and is used by the inhabitants of the Steppes of Russia as a sovereign remedy in phthisis. Cases are named where the patient gained considerably in weight by taking half a tumbler-full night and morning; but the dose must be regulated by the peculiarities of the patient. Nor is it indifferent whether the fermentation is carried on to a greater or less extent.

LIST OF APPLICATIONS FOR LETTERS PATENT.

"We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated February 21st, 1866.

536 L. Brown, W. Wheeldon, and G. N. W. T. Thompson—Stop cocks
537 H. Bayliss—Brushes for cleaning gun barrels
538 W. Webb—Manufacture of tubes and hollow cylinders
539 H. P. Swift—Construction of pumps
540 B. W. Richardson—Apparatus for refrigerating liquids
541 W. Deokin—Construction of certain parts of metallic chests
542 J. Smalley—Looms for weaving
543 N. R. Hall—Weighing apparatus
544 W. D. Napier—Improvements in fountains

Dated February 22nd, 1866.

545 J. D. Brunton—Peat fuel
546 M. Robinson, J. Robinson, and W. Smith—Reeds used in looms for weaving
547 E. Leak—Driving jiggers
548 J. Walker—Vessels of war
549 H. Bright—Electric clocks
550 C. de Caesaris—Preparing hides and skins for tanning
551 N. Legendre—Manufacture of lace gauze

Dated February 23rd, 1866.

552 J. C. Haddon and H. J. Haddan—Improvements in iron safes
553 J. Fordred—Treatment of certain products obtained in the refining of petroleum
554 C. J. Coumon—Manufacturing iron and steel
555 J. Pass—Manufacture of elastic reeds and combs for weaving
556 W. Nunn and C. W. Brown—Ships' binnacle lamps
557 J. Parker—Apparatus for obtaining motive power
558 J. Goodfellow—Pump buckets
559 W. Tongue—Machinery for preparing fibrous materials
560 M. Samuelson—Means of saving life at sea
561 J. F. Hearsey—Construction of spirit meter
562 J. Dodge—Apparatus for tempering saws
563 T. J. Smith—Steam engines
564 J. Holy—Railway brakes
565 R. Milburn and W. H. Baxter—Treatment of brewers' and distillers' grains
566 P. Kerr—Arranging and working steam engine valves
567 N. Fisher—Machinery for cultivating land
568 G. E. Donisthorpe—Machinery for combing wool
569 J. Scott Russell—Building ships of war
570 C. Mather—Machinery for washing yarns

Dated February 24th, 1866.

571 R. Leake and J. Beckett—Machinery for engraving and etching rollers
572 W. Richmond, T. Richmond, and J. Richmond—Manufacture of healds
573 J. I. Barber—Improvements in skates
574 T. Bulley—Apparatus for cleaning the bottoms of iron and other vessels
575 G. Haseltine—Construction of railways
576 T. Spencer—Manufacture of articles of earthenware
577 J. Petrie—Machines for washing wool
578 W. E. Newton—Breech loading firearms
579 F. C. Winby and C. E. Winby—Application of power in actuating rolls in rolling metals
580 W. Welch—Manufacturing and applying cements
581 P. H. Lealand—Binocular microscopes
582 I. L. Pulvermacher—Apparatus for producing and applying galvanic currents
583 F. L. Hancock and C. L. Hancock—Driving belts
584 W. H. Prior—Apparatus applicable as a fire-escape

Dated February 26th, 1866.

585 J. Thomas—Gas meter indexes
586 T. Edwards and S. Iniff—Registering the number of passengers entering omnibuses
587 J. Pickin and R. Bailey—Apparatus for signalling on railways
588 F. M. Jennings—Preparation of flax
589 C. E. Treadwin—Modes of making certain kinds of lace
590 W. E. Gedge—Method of agglomerating peat
591 J. H. Johnson—Construction of roads and streets
592 W. Clark—Pin cartridges
593 S. Rydbeck—Breech loading firearms

Dated February 27th, 1866.

594 W. E. Gedge—Extracting the juice from sugar cane
595 W. P. Le Keux and F. A. Wisbart—Detonating and light signals for railways
596 W. Allanson and R. Lowe—Shuttles for weaving
597 C. G. Hill—Apparatus for cutting lace fabrics
598 H. Wilson—Sawing machinery
599 R. Yeates—Travelling knife for opening provision cases
600 G. Zanni—Applying motive power to sewing machines
601 J. H. Forshaw—Revolving shutters
602 M. Myers, M. Myers, and W. Hill—Apparatus for the use of smokers
603 H. Robertson—Manufacture of oil
604 F. M. Edeu—Holding and driving cutting and other tools
605 M. Cole—Street cabs and harness
606 W. E. Newton—Apparatus for distilling petroleum
607 J. Trent—Even balanced tubular slide valve for steam or other engines
608 W. R. Lake—Weighing machines

Dated February 28th, 1866.

609 J. Hick—Clip for fastening leather
610 D. L. Cohn—Breech loading revolving firearms
611 R. A. Brooman—Casting metals
612 F. Brampton—Files for holding letters
613 J. Norman and J. Copeland—Apparatus for producing ice
614 J. B. Booth—Flyers used in machinery for preparing cotton
615 H. A. Dufrene—New applications in the manufacture of beer
616 W. E. Newton—Apparatus for the distillation of tar
617 W. E. Newton—Apparatus for extracting tan
618 G. Cowdery—Machinery for making bricks
619 R. Clark—Improvements in signal lamps and in gas burners

Dated March 1st, 1866.

620 S. Henton and C. J. Henton—Rotary brushes and apparatus for brushing
621 J. D. Dow—Steam boilers
622 C. Powell—Watches and other timekeepers
623 A. C. Andrews—Screw rivets for boot pegs
624 E. Cottam—Hydraulic presses
625 J. Young—Distilling coal
626 J. Skinner—Steering apparatus
627 W. Weldon—Process for obtaining soda from common salt
628 W. Weldon—Manufacture of soda from common salt
629 W. Weldon—Manufacture of soda from common salt
630 H. McPhoil—Raising and forcing water
631 W. R. Lake—Improved spike
632 W. Beare Caulfield—Chains and apparatus used for submarine purposes
633 E. Loomes—Machinery for planting potatoes
634 W. Conisbee—Grinding and equalising the thickness of lithographic stones

Dated March 2nd, 1866.

635 W. Rogers—Construction of the permanent way of railways
636 G. P. Evelyn—Projectiles for ordnance and firearms
637 J. Carpenter—Keys for watches and clocks
638 W. Clark—Steam vessels
639 E. W. Otway—Chaff cutting machines
640 A. V. Newton—Apparatus for loading waggons with hay
641 J. Tansley—Construction of safes

Dated March 3rd, 1866.

642 V. Larnandes—Medicine for cattle
643 R. Walker—Apparatus for calendering
644 J. W. Friends—Two wheel vehicles
645 J. Clark—Railway brakes
646 G. Prentice and A. B. Inglis—Annealing of metallic plates
647 W. Deakin and J. B. Johnson—Application of a certain material in combination with improved means and appliances for the manufacture of tubular bodies
648 A. Hosking—Apparatus for rendering safes more secure
649 J. Spear—Construction of vices
650 J. Pollit and E. Pigzell—Drying Steam
651 W. E. Newton—Operating railway carriage brakes
652 E. E. Colley and W. Moss—Self acting card distributor
653 W. Clark—Rose engines
654 N. Thompson—Tools for dividing wood into cylinders
655 J. Stevenson—Perforating rocks
656 C. G. Hill—Ornamenting lace fabrics
657 J. Bischoff—Steam cultivators
658 C. Ravelli—Apparatus for saving life at sea

Dated March 5th, 1866.

659 M. A. F. Mennons—Converting the fibrous residues of certain plants into filaments suitable for the manufacture of textile fabrics
660 J. H. Player—Improvements in the manufacture of phosphorus
661 J. Stocks—Superheater for a certain class of steam boilers
662 J. Crean and C. J. Barr—Fire alarm
663 W. A. Verel—Distilling petroleum and the oils obtained from coal
664 W. F. Stanley—Mathematical drawing instruments
665 H. Hackett—Safety valve for steam boilers
666 G. Davies—Construction of portable steam engines
667—J. Gray—Preparations for acting upon sea water
668 W. H. Berry—Steam hammers
669 T. Clayton—Producing illuminating gas from inflammable liquids
670 G. L. Leclanche—Piles for generating electricity
671 C. W. Siemens—Manufacture of zinc
672 A. V. Newton—Process of bleaching
673 W. E. Newton—Construction of ordnance

Dated March 6th, 1866.

674 G. Haworth, T. Parrington, and W. Hudson—Preparation for sizing cotton
675 R. G. Allerton—Waterproof fabrics
676 J. Broadbent—Winding yarn
677 M. Henry—Firearms
678 E. Rimmel—Portable fountains
679 R. Donaldson—Means for signalling on railway trains
680 W. R. Lake—Machinery for making bolts and other similar articles
681 S. Soutar—Apparatus for cleaning the tubes of steam boilers
682 A. C. Campbell—Superheating steam
683 J. Norman—Washing an mal charcoal or charcoal substitutes
684 A. V. Newton—Improved mode of working air engines
685 J. Chubb—Iron safes and strong rooms
686 A. Barker—Manufacture of wadding
687 G. T. Bousfield—Machinery for making eyelets
688 W. Richards—Breech loading firearms and cartridges

Dated March 7th, 1866.

689 A. Stoddart—Apparatus to be employed in illusory exhibitions
690 H. F. Davis—Artificial tea from pure bichromate of ammonia
691 J. Patterson—Reducing hard substances
692 W. Machin and S. Machin—Cleaning ships' sides and bottoms
693 G. Randle—Conveying tidings of the loss of vessels at sea
694 G. Price—Construction of wrought iron burglar proof safes
695 E. Roberts and H. Roberts—Mills for grinding wheat
696 A. C. Baldwin—Rotary steam engines
697 H. Chandler—Screw keys
698 W. Thomson—Railway crossings
699 G. T. Bousfield—Apparatus used in expanding boiler tubes

Dated March 8th, 1866.

700 T. Prideaux—Puddling and converting furnaces
701 W. Atkinson—Apparatus employed in casting in metals
702 J. G. Willans—Puddling iron
703 G. E. Donisthorpe—Cutting coal
704 S. F. Schoonmoker—Dredging and elevating machinery
705 J. Tomlinson—Means for indicating the quantities of liquids contained in casks
706 S. S. Brown—Gas burners
707 J. Hunt—Arrangements of mechanism for washing and separating ores
708 J. B. Muschamp and J. W. Card—Improvements in steam engines
709 J. A. Norman and A. Norman—Pen and pencil holders
710 W. Russ and T. W. Wedlake—Distributing water and liquid manure
711 A. Trotman, J. Trotman, and T. J. Cole—Hair pins

Dated March 9th, 1866.

712 W. Fleming—Protecting hatchways in ships
713 W. H. Fletcher—Washing machine
714 C. Harvey—Breech loading firearms
715 V. Duterne—Metallic stuffing box
716 T. Pattison and J. Booth—Improvements in metallic pistons
717 T. B. Moxon—Improvements in safes
718 A. T. Macha tie—Improvements in preservative coatings
719 E. T. Hughes—Improvements in pumps
720 E. T. Hughes—Weighing scales
721 E. Forster—Side propellers for navigable vessels
722 T. Restell—Breech loading firearms
723 H. T. Humphreys—Reflecting optical instruments
724 J. Mair—Machines used for lithographic printing
725 B. Hadley—Bearing springs for carriages
726 J. Baker—Magnetic engines
727 A. V. Newton—Melting of iron
728 W. E. Newton—Paddle wheels for propelling vessels
729 R. Larkin—Obtaining light by the combustion of magnesium

Dated March 10th, 1866

730 T. Wallwork—Apparatus for reckoning quantities
731 C. J. Richardson—Arranging steam boilers
732 G. Phillips—Preparing purple and blue colouring matters
733 W. C. Myers and E. Myers—Construction of meters
734 W. Simons—Construction of ships
735 W. E. Gedge—Manufacture of studs
736 D. Callafeut—Improvements in pumps
737 R. A. Boyd—Cooling bacon curing rooms
738 M. P. W. Boulton—Improvements in generating heat
739 C. Huntley—Improvements in cricket balls
740 P. H. Ashberry—Manufacture of articles made in Britannia metal

Dated March 12th, 1866.

741 S. Jakins—Prevention of the smoking of chimnies
742 H. A. Bonneville—Means of ascertaining the weight and postage of letters
743 H. A. Bonneville—Improvements in funnels
744 T. A. Mathieson—Holding devices for boring tools
745 J. H. Mullin—Sliding shutters for shop and other windows
746 C. Linford—Apparatus for paring
747 G. Severn—Means employed in evaporating and cooling liquids
748 J. Macintosh—Impervious compounds
749 A. V. Newton—Improved construction of instrument

Dated March 13th, 1866.

750 G. H. Smith—Materials for polishing metallic substances
751 S. Fillingham—Improvements in the manufacture of felted cloths
752 F. G. A. Horstmann—Self winding of clocks
753 W. F. Deane—Treatment of the residual liquor arising from the production of chlorine gas
754 J. Jessop and W. Warburton—Doors or covers of safes
755 G. Booth—Reaping hooks and sickles
756 J. F. Brinjes—Machinery for distilling bituminous shale
757 J. B. Vuldy—Steam boiler and other furnaces
758 L. Kaberry—Machinery for preparing fibrous materials

Dated March 14th, 1866.

759 J. Elder—Boilers and engines of steamships
760 E. Russ, H. Hammond, and E. Hammond—Firearms
761 J. W. Yates—Improvements in spades
762 M. Lowenstein—Improvements in bracelets
763 J. F. Belleville—Construction and arrangement of springs
764 J. Varley—Drill and other braces
765 W. Clarke—Ironing and finishing linen
766 S. S. Merriam—Submarine and torpedo boat
767 E. W. Bunnett—Revolving shutters
768 R. Gutteridge—Sewing machines

Dated March 15th, 1866.

769 G. McKenzie—Obtaining illuminating gas and oil
770 R. Morton—Machinery for tunnelling
771 E. Lichtenstadt—Improved lamp
772 O. C. Evans—Digging machinery
773 A. G. Lock—Manufacture of manures
774 M. J. Roberts—Protecting iron ships
775 M. Morse—Machine for pressing straw hats and bonnets
776 B. W. Selby—Manufacture of lace in twist lace machines
777 J. Cole—Elastic gusset webs
778 W. Goodwin—Rotary steam engines
779 T. G. Ghislin—Preparation of peat
780 W. Hutchinson and F. Jolly—Machinery for beetling woven fabrics
781 F. H. Gossage—Cleaning cotton seeds

Dated March 16th, 1866.

782 T. Bigg—Machinery employed in the manufacture of waterproof fabrics
783 W. C. Fuller and J. Margetts—Apparatus connected with the games of cricket and billiards
784 E. Tonks—Casement stays and other stays
785 W. Bates and F. Bates—Fulling machines
786 T. Mawock—Manufacture of cheese
787 T. J. Reader—Force pumps
788 A. Pilling—Sewing machines
789 J. H. Johnson—Breech loading firearms

Dated March 17th, 1866.

790 E. R. Wethered—Indicating the shot mark on target at ball practice
791 H. B. Barlow—Construction of fans
792 T. Sugar and G. Keighley—Construction of safes
793 W. Dancer—Dyeing and printing textile fabrics
794 J. Shanks—Steam boilers
795 R. Badger—Shears and scissors
796 P. C. Bakewell—Rolling and straightening cylindrical rods and tubes
797 R. H. Ashton—Pictures obtained upon paper
798 J. Heston—Conversion of cast iron into steel
799 F. Hinton—Improvements in safes
800 O. W. Jeyes—Manufacture of ice
801 C. W. Standish—Stoppering bottles
802 N. Thompson—Manufacture of box s
803 P. Michaud—Railway wheels
804 G. Zanni—Obtaining motive power

Dated March 19th, 1866.

805 J. Higginbottom—Construction of brushes for polishing paper
806 T. G. Sylven—Breech loading guns
807 E. Bencher and J. Gillot—Machinery for mining
808 J. Campbell, S. McKinstry, and T. Wilson—Machinery for preparing flax
809 J. Chambers—Laying veneers on to mouldings
810 W. E. Gedge—Pneumatic steam dredging machine
811 E. Field and F. Lloyd—Diffusing moisture and heat through vegetable or other matters.
812 T. Routledge, T. Richardson, and W. H. Richardson—Treating waste liquors
813 C. S. Oshorne—Compound applicable to the lining or covering of bearings
814 A. A. Croll—Arranging conduits for the reception of gas

Dated March 20th, 1866.

815—H. B. Barlow—Machinery for spinning
816 H. King—Construction of coffer dams
817 W. Dicks—Improved ratchet brace
818 R. A. Jones and J. C. Hedges—Fire escape
819 J. Ramsbottom—Obtaining motive power
820 W. S. Laroche—Producing new effects in photographic portraiture
821 W. Naylor—Prevention of smoke
822 A. R. Burr—Gun and pistol barrels
823 B. Swain and P. Oddfield—Balling wool
824 T. N. Kirkham, V. F. Ensom, and H. Brook—Apparatus for scouring
825 P. G. B. Westmacott—Pillar cranes
826 H. J. Anderson—Hollow projectiles
827 W. E. Newton—Distilling petroleum
828 W. Clarke—Treatment of jute and China grasses
829 J. Deuis—Improved gridiron
830 F. P. Warren—Improvements in frying pans

Dated March 21st, 1866.

831 L. R. Podmer—Self acting mules for spinning
832 S. Dalby—Cutting coals
833 H. Stead—Opening fabrics during their passage through machinery
834 C. E. Brooman—Improvements in projectiles
835 J. Thompson and B. Grayson—Improvements in bread plates and dishes
836 C. H. Parker and H. Rossell—Improvements in vices

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MAY 1st, 1866.

ON THE PROPERTIES OF WOOD.

Tbe almost universal application of iron in civil constructions, in the preseut age, and especially in this country, renders us too apt to forget the study of those properties of wood with which, even on general grounds, the engiueer should be conversant, and the knowledge of which becomes so much more important when we reflect that wood almost exclusively served the purposes of man in his building operations, up to a comparatively recent period, and tbat on many grounds it yet remains the king of all building materials.

The following uotes form tbe substance of a few lectures delivered on this subject, by Mr. J. J. Birckel, as professor of engineering, to his pupils at tbe Queen's College, Liverpool, and will not fail to be interesting to many of our readers, especially to thosc of the younger oues who peruse our pages in search of practical and permaueutly useful knowledge.

By wood we understand that portion of the substance of a tree which lies between the bark and the pith, aud which may be subdivided into two distinct parts, namely, the *sapwood*, or tbat portion which has been more recently formed, and the heartwood, or that portion wbich has been formed during the earlier stages of the growth of the tree, and which, after a certain time, may be said to have become perfect wood. Tbe sapwood diffcrs from tbe heartwood by its lighter shade of colour, and by its softness, and according to most recent observations, it is formed by tbe sap in its downward course which then takes the uame of *Cambium;* tbis substance which is formed yearly between the bark and tbe sapwood of last year's growtb is liquid and translucid at first, but thickeus gradually and forms towards the inner side of the tree a uew layer of sapwood, and towards the outer side a tbin layer of the inner part of tbe bark, which thus keeps renewing itself in consequence of the outer envelope pealing off with more or less regularity. It will thus be perceived tbat perfect wood is formed by the gradual hardening of the fibres of the sapwood, and consequently tbat no very distiuctive outline denotes the sapwood from tbe perfect wood, since the textures of the inuer layer of the former, and of the outer layer of the latter, must be very nearly similar.

In the growth of a tree the functions of the bark are uot only of a protective kind, but are somewhat similar to those of tbe lungs in animal life; through it the tree inbales the atmospheric air, and within its tissues the carbonic acid contained in the air is decomposed, tbe carbon being appropriated by the tree, and the oxygen again rejected. This phenomenon, however, takes place only under tbe infiuence of the light of tbe sun. Thus the functions of the bark are similar, if uot identical to those of the leaves who, under the influence of tbe light of the sun, also inhale carbonic acid,—eliminating the carbon and exhaling tbe oxygen,—but who, during night-time, absorb the oxygen of the atmospheric air wbicb they inhale, and reject the carbonic acid.

Tbe pith seems to be the vital power and the main-spring of the life of the tree; the casing within whicb it is contained is made of a series of tubes parallel to each other lengthwise to the tree, and this casing when once formed never changes its size or its shape during the remainder of tbe life of the tree; the pith, moreover, communicates with tbe bark, and through it with tbe atmosphere by a series of radial tubes wbich are always filled with air.

Thus in examining the cross section of the trunk of a tree we observe first, in the centre, the pith, then the heartwood, next the sapwood, tben the cambium, and finally the bark, itself made up of three distinct layers, each of which bas distinct functions, the wood proper being composed of a successiou of layers, the number of which depends on the age of tbe tree, as has been previously explained, which in cross section exhibit so many rings, and the radial tubes above mentioned, connecting the pith with the bark, cause the whole to assume tbe appearance of a spider's web.

Tbe thickness of the riugs indicative of the yearly addition to the bulk of the stem of the tree, and which, in a great measure, also gives a fair indication of the feature of the wood, depends upon the various circumstances of tbe growth of the tree, and is influenced by the nature of the soil, the climate and the weather.

Fir, which grows on very dry marl, forms very narrow yearly rings; but if grown on rich and damp marl, they are very thick; if grown on wet soil they are again smaller, and the common fir grown ou more soil, has even smaller yearly rings than if on dry sand or marl. From this it becomes evident tbat neither a too wet nor too dry a soil are suitable to the favourable growth of this tree.

The alder (*betuala alnus*), the willow (*salix*), tbe beech (fagus sylvataca), and also the ash (Fraxinus), grow best on wet and fat soil, and tbrive but poorly when standing dry; the oak grows best upou a dry aud elevated soil and in a temperate climate; the birch thrives upon rocky soil, aud the mountain ash upon damp soil in cold situations.

A white fir tree twenty-five years old and situated in a tolcrably suitable ground, may have a diameter of 3in. or more, whilst another on dry ground will be but 1in. tbick; in the former the rings will be nearly three millimetres thick, and in the latter they will be less thau one millimetre, and if the cross sectiou of each be submitted to examination uuder tbe microscope, the former will appear like a net with large pores, while the latter will look almost like oue solid mass. Tbis fact may serve to illustrate how difficult it is to say that a given kind of timber is able to resist such and such a strain, and to this cause probably also might be traced many accidents which do not find their immediate origiu in the rotten or otherwise bad conditiou of timber. On this account sbould tbe greatest possible attention be paid to this point iu tbe selection of timbers for masts and spars in shipbuilding yards, and great skill and discrimination is required on tbe part of tbose engaged in those operations.

Tbe average widtb of the rings in firs is 2·4 millimetres, with a sligbt decrease near the bark; they arc smallest in Swedish and Russian firs, and tbat circumstance has been ascribed to tbe sbortness of tbe summer in those climates; the same phenomenon, however, appears in firs grown in more southern climes, which shows that similar results may be brought about by opposite causes; in tbe latter case the circumstance, no doubt, is due to great drougbt.

Tbe leafwoods with large pores are deserving of special observation, in tbem tbe size of the yearly rings, within certain limits, is not necessarily indicative of greater porosity or less density, aud in tbe case of oak it may happeu that narrow yearly rings are a sign of porus timber unfit for building purposes; in the case of these woods, therefore, great discrimination is required in tbe choice of timber. Wood, however, whose yearly rings are more tban six millimetres wide, over a section of several inches sbould never be used for building purposes. Sucb timber is the produce of trees whicb have grown in marshy or clammy soils, along the banks of brooks or rivers, and are fit only for firewood. Great difference of thickuess iu the rings of the same stem occur continually, a fact which

finds its explanation in the circumstances of the growth of the tree, its position and surrounding influences; in excentric stems the rings are broader on the projeeting than on the flat side, inclined stems show them smaller on the upper side, but the assertion that the rings are broader on the south side of the stem than on the north side is devoid of truth.

The following table shows the mean yearly growth of various timbers with their approximate specific gravity when dry :—

Name of Timber.	Annual Growth in Millimetres.			Specific Gravity.
——	Circumference.	Thickness of Ring.	Height.	——
Oak	16	2½	300	0·934
Elm	23	3½	360	0·554
Beech	20	3	—	0·696
Ash	30	4½	360	0·760
Pine	17	2½	540	0·745
Fir	20	3	570	0·660
Larch	19	3	—	0·543
Cedar	39	6	65	0·603
Poplar	36	5½	1,350	0·588
Birch	21	3½	650	0·701
Sycamore	20	3	—	0·755
Lime	27	4	300	0·687
Willow	59	9½	—	0·421
Acacia	32	5	—	0·676
Pear	6	1	—	0·705
Apple	22	3½	—	0·735

Some trees are said to be as old almost as the creation of life on the globe, as, for instance, the *wellingtonia* of California (*squoia sempervirens*), and there is a yew tree at Forheingal in Scotland, whose age is computed at 2,500 years, the olive trees of biblic renown in connection with the life of Christ are said to be still extant, and even our familar oak may live 600 years; but long before trees have reached that age, their timber has become useless for building purposes, and there is a period in the life of trees, varying with each kind, when the wood has reached that stage of that maturity it should be cut down if it is to yield timber of good and durable quality. The following is a table of the mean age of trees when they have reached their stage of maturity.

	Years.		Years.
Oak (quercus robur)	250	Piue (pinus silvestris)	80
Chestnut (castanea vesca)	200	Sycamore (acer pseudo platanus)	50
Lime tree (tilia Europæa)	100	Alder (betula alnus)	50
Maple (carpinus betulus)	140	Birch (betula alba)	40
Beech (fagus silvatica)	120	Poplar (populus alba)	30
Elm (ulmus campestris)	100	Willow (salix alba)	40
Fir (abies excelsa)	100		

An indication of the age of a tree is afforded by the angle which the lower branches make with the stem. When that angle is from 40 to 50°, the tree is in its prime; when it has reached 60° the tree begins to die, and it should be forested before then. In some instances the scent of the woods may enable us to form an idea of their condition of health; thus, in passing in the early spring a number of old white poplars, an obnoxious smell may be noticed proceeding from the sap which flows from the decayed interior to the outside. Pinewood will retain its natural smell for years; leafwood trees have mostly a sour smell, and it is reckoned that the stronger it is the healthier is the wood; should this smell be faint we may infer that the tree is dying off.

The sap which circulates in the tree, and promotes its life, forms a considerable body in green or fresh wood; it changes more or less the quality of timber, and the intimate study of its influences is of great technical importance. It had long been assumed that trees coutain the least amount of moisture during the winter months, and on this ground also, was that season of the year chosen to fell timber; experience teaches that for northern climates that season is really the best, in order to obtain a good and durable timber, although from experiments made by the French savant, Duhamel, it appears that the December woods contain the greatest amount of moisture. It would seem, therefore, that it is uot so much the quantity of sap, as the activity with which it is circulating in the tree, while it is being felled, that exercises a determinating influence upon the durability of the timber; timber felled in summer is sooner attacked by worms, and is more liable to take the dry rot than timber felled in autumn and the beginning of winter. In the United States, however, it has been found since 1812, that timber felled in June is very strong and durable, though more difficult to work. In southern climates, practical men attach great importance to the age of the moon, while the timber is being felled; thus, timber cut during the first quarter of the moon is sooner attacked by worms, than timber cut during the last quarter, a fact which is, no doubt, due to the condition or state of activity of the sap, upon which the phases of the moon are known to have a great influence; the ancients were alive to this influence, and Pliny prescribed the last quarter of the moon for felling timber.

Referring again to the quantity of sap contained in trees at various seasons of the year, we here record a few of Duhamel's experiments on the subject, taken from his work on "Exploitation des bois." During the year 1732-33, he had felled, during each month, eight oaks of equal age and grown upon the same spot. These were cut into twenty-five pieces, each 3ft. long and 3in. square (Paris measure), and the weights were as follows:—

	lbs.		lbs.
December wood	340·718	June wood	297·312
January ,,	340·905	July ,,	297·250
February ,,	328·031	August ,,	314·469
March ,,	331·087	Sept. ,,	306·875
April ,,	311·875	October ,,	328·906
May ,,	319·500	Nov. ,,	331·000

N.B.—1lb. Paris weight=1·0769lb. English avoirdupois.
1ft. French=13·12in. English; and 1in. French=1·093in. English.

The above figures show conclusively, that the December and January woods contain more moisture than those of any other season of the year; it diminishes in February, March, April, aud May; is smallest in the months of June and July, and gradually increases in August, September, October, and November. Another experiment made in 1737-38, showed the specific gravity of the lower portiou of the stem of young oaks to be as follows:—

December wood,	1,132
April ,,	1,016
July ,,	1,017

The same pieces of wood were also weighed when dry, in order to ascertain the loss of weight by evaporation of sap, and the following is the result obtained:—

	Green.	Dry.	Loss of sap.	per centage of loss.
April wood	57·339	41·839	15·500	27
July ,,	94·851	68·226	26·625	28
Dec. ,,	77·062	52·375	24·687	31·2.

This experiment exclusively shows that the amount of moisture is greatest in December, and least in July aud April, with but a very slight difference between the two latter samples. A more recent author, Mr. T. Hartig, a learned forester of Germany, establishes the same fact, namely, that in most kinds of woods the trees contain the greatest amount of moisture during the months of January and February, thus entirely exploding the prevailing notion that trees contain a greater amount of sap during spring than at any other season.

A difficult question is that of seasoning timber properly, when once it is

cut, and it is an operation of much tediousness when it is not performed by artificial means, and with either method, natural or artificial, requires great care and discrimination. For a time it was believed that that question was thoroughly solved by barking the tree *in situ*, before felling it, and it was believed that great advantages were derived from this method, because with it the sapwood hardens, and to all appearance, even in color, assumes all the properties of perfect wood; tbis transformation, however, is only factitious; for under this treatment the heartwood looses its weight and body, becoming actually lighter than the sapwood, and the whole becomes brittle and looses its elasticity, one of its most valuable properties. It is stated, also, that timber thus dried *in situ*, takes the dry rot much more readily than timber dealt with in the ordinary manner. In stowing timber for the purpose of seasoning, care should be taken to protect it from the direct action of the sun, and from the action of strong sharp winds, otherwise the pores of the outer layers become closed up, evaporation is stopped, and dry rot sets in very soon. In order to accelerate desiccation, timber is frequently immersed into water which dissolves the sap, and when it is afterwards taken out of tbe water it dries very rapidly. When it is dried artificially in stores, care must be taken not to carry the process of desiccation too far, because the timber then becomes brittle and looses its strength and elasticity. This is a danger inherent to all methods of artificial desiccation. According to Mr. Hartig, wood felled in December and January contains above 50 per cent. of its weight in sap and moisture, and when it is air-dry it still retains about 20 per cent of it.

(*To be continued.*)

THE SUGAR QUESTION.

We have, on former occasions, referred to "The sugar question," which is agitating our commercial men on the one hand, and the planters on the other. Whilst cane-sugar had no competitor, everything about it was common-place enough. Now that the beet-root sugar is competing in price, all concerned are compelled to exert themselves. The planter has looked at Quashi, and found "the nigger" in the deep rut of routine, and helpless. Science, hitherto neglected, has been implored for assistance. Science has done, and is always doing much that is beneficial, to gratify her own appetite for goodness, for perfection, however laborious the task. We extract a highly interesting translation, from our excellent contemporary, *The Chemical News*. It can teach us more than one lesson, as it exhibits some of those intricate manipulations with which the analysis of sugar, and its congeners, is associated. If to these, we add the necessity for practical experience, we may comprehend some of the difficulties to be overcome, before the planter can realise all the sugar in the cane. Engineers have studiously approached the manufacture of sugar; they suggested such alterations and improvements as appeared to be desirable, of course with some one of the metals, and still one half of the contained sugar is daily lost to the planter. When planters have read the following, and the narrations of similar examinations, they can the more clearly perceive how engineers have failed, with themselves, to comprehend one of the most delicate subjects in organic chemistry, without damage to their well-earned professional reputation.

RESEARCHES ON SUGAR AND SUGAR-LIKE BODIES* BY L. CARIUS.

A Sugar-like Body from Benzol.—If grape-sugar and isomeric bodies like inosite, be considered as hexatomic alcohols, their formula would lead us to suppose the existence of a radical $C_6H_6^{iv}$. We might, therefore, expect to find similar relations existing between this hypothetical radical and benzol C_6H_6, as are known to exist between ethylene and ethylene alcohol.

Some experiments, made by the author, prove that benzol may be converted into a sugar-like body, which is not, however, grape sugar, nor any other known compound, but a new body, to which he has given the name *Phenose.*

* Abridged from *Annalen der Chemie und Pharmacie*, Dec. 1865.

The author has already shown, that benzol combines directly with hypochlorous hydrate, to form a compound which he calls *trichlorhydrine of phenose.*

$$C_6H_6 + \left[O\left\{\begin{matrix}Cl\\H\end{matrix}\right.\right]3 = \begin{matrix}O_3\\Cl_3\end{matrix}\left\{\begin{matrix}C_6H_6\\H_3\end{matrix}\right.$$

This body is difficult to produce in quantity. The benzol has to be added to a concentrated solution of hypochlorous acid, wben a portion of it combines with the benzol, but by far the greater portion becomes decomposed. The best mode of proceeding is to take 216 grammes of oxide of mercury* and a litre of water, and 26 grammes of benzol. The solution of hypochlorous acid, prepared by aid of the above amount of oxide of mercury, is placed in iced water, the benzol added, and the mixture strongly and repeatedly shaken for about two days, till all the hypochlorous acid has disappeared. With tbe above quantities about six grammes of the trichlorhydrine may be prepared, nearly all of which will be in solution.

The solution is first filtered, then precipitated with sulphuretted hydrogen, again filtered, and now saturated with common salt. The trichlorhydrine is now separated by repeatedly sbaking the mixture with ether. After distilling off the ether, trichlorhydrine remains behind, as a thick colourless liquid, which must be kept at a low temperature, protected from the air. Crystals gradually form in the solution, and the mother liquor, evaporated over sulphuric acid, still yields pure chlorhydrin.

The crystals are colourless, and often large thin plates; under the microscope they appear broad needles, similar to benzoic acid. They fuse at about $+ 10^\circ$, readily absorb moisture, and become converted into a brown tarry product. When heated, a part volatilises unchanged; but below 100° some undergoes partial decomposition. They are soluble in alcohol, ether, and benzol, but sparingly soluble in water. They quickly, however, attract moisture from the air, forming a viscid liquid. They have a faint peculiar smell, and a burning taste. On analysis the crystals gave the following results :—

	Found. I.		Found. II.		Calculated for formula $C_6H_9Cl_3O_3$.
Carbon	30·80	...	30·72	...	30·57
Hydrogen	4·00	...	3·87	...	3·82
Chlorine	45·01	...	45·05	...	45·23
Oxygen	—	...	—	...	20·38
					100·00

Alkalies decompose trichlorhydriue, eliminating the whole of the chlorine; but, besides the chloride of the metal, two other bodies are always formed, tbe one being benzoic acid and the other *Phenose.* The following equation explains the formation of the latter body :—

$$\begin{matrix}O_3\\Cl_3\end{matrix}\left\{\begin{matrix}C_6H_6\\H_3\end{matrix}\right. + {}_3\left[O\left\{\begin{matrix}K\\H\end{matrix}\right.\right] = O^6\left\{\begin{matrix}C_6H_6\\H_6\end{matrix}\right. + {}_3KCl$$

The trichlorhydrine, in its behaviour with nitric acid, resembles the organic bodies rich in hydrogen, the so-called fatty bodies. Heated with dilute nitric acid, it is easily oxidised, forming oxalic acid. The author conld form no nitro-compound.

Phenose $$O_6\left\{\begin{matrix}C_6H_6\\H_6\end{matrix}\right.$$

is extremely difficult to produce. Trichlordrine and a solution of potash form almost nothing but benzoic acid, and the necessary excess of potash converts any phenose produced into a humus-like body. The best mode of proceeding is as follows :—One molecule of trichlorhydrine is dissolved in a little alcohol, and sufficient water is added to produce a clear solution containing about 1 per cent. This solution is decomposed with three molecules of carbonate of soda; and the solution, which soon turns brown, is digested on a water bath for six or eight hours, after which it is carefully neutralised with hydrochloric acid. To remove any benzoic acid which may have been formed, and also any undecomposed trichlorhydriue,

* The author no doubt means, although he does not say so, that this quantity of oxide of mercury is to be treated with chlorine to produce hypochlorous acid; and the solution of hypochlorous acid so produced is to be employed in the subsequent part of the process.

the solution is repeatedly shaken with ether; the ether is removed, and the remaining solution is evaporated nearly to dryness. The moist mass of chloride of sodium, &c., is now treated with alcohol, and the alcoholic solution evaporated; the residue is again treated with strong alcohol, and the solution is filtered. The filtrate contains the phenose, with some chloride of sodium, forming a compound answering to the formula $C_6H_{12}O_6NaCl$.

This last alcoholic solution must now be slightly acidulated with acetic acid, and then precipitated with acetate of lead, ammonia is added to the filtrate, which is then precipitated with ammoniacal solution of acetate of lead. The precipitate is well washed, and then decomposed under water by sulphuretted hydrogen; the filtrate is freed from any traces of hydrochloric acid by the addition of carbonate of silver, and if it is not quite colourless, it is treated with animal charcoal, and evaporated.

The tenacious residue must now be examined for chlorine, and if any is present, the aqueous solution must be treated with caustic baryta $(BaHO)_2$ to one atom of the chlorine, the baryta carefully removed by sulphuric acid, and the hydrochloric acid by carbonate of silver; the filtrate is then again evaporated.

The syrupy residue, after standing a long time over sulphuric acid, leaves the phenose as a slightly colourless amorphous mass, which quickly deliquesces in the air. It has a sweetish taste, similar to that of grape sugar; it is readily soluble in water and alcohol, but is insoluble in ether. An analysis of the author's product gave the following results:—

	Found.	Calculated for the formula. $C_6H_{12}O_6$.
Carbon	39·68	39·99
Hydrogen	6·99	6·68
Oxygen	——	53·33
		100·00

When heated, phenose becomes brown, and decomposes below 100°, exhaling an odour like caramel. When subjected to dry distillation, it gives a distillate containing acetic acid and tarry matter, and leaves a carbonaceous residue. On being heated with dilute acids or alkalies it is converted into a humus-like substance, and an acid which appears to be glucinic acid.

It is difficult to prepare compounds of phenose with the alkali metals. A lead compound however, may be prepared having the composition—

$$O_6 \left\{ \begin{array}{l} C_6H_6 \\ Pb_3 \end{array} \right.$$

which shows that 6 at ·H are replaceable by a metal. All attempts to prepare an ether have failed, in consequence of the easy decomposability of phenose.

Phenose is as easily oxidised as grape sugar. Even when gently heated with nitric acid it forms oxalic acid; with oxide of copper it behaves exactly as grape sugar; with a silver salt an alkaline solution separates metallic silver. It does not, however, ferment in contact with yeast.

These facts place beyond doubt the existence of a sugar-like body which must be regarded as a hexatomic alcohol, and which stands to benzol in the same relation as ethylen alcohol stands to ethylen; and therefore confirms the opinion that the ordinary known sugars are alcohols.

The Determination of Sugar in Barley, and in the Products of the Malting Process.*

I. *Determination by the Fermentation and Alcohol Method.*—The grain, unmalted or malted as the case may be, being finely ground, 630 grains were stirred up with 200 septems† of cold water, and the mixture allowed to stand for about an hour. It was then well rubbed in a mortar, and transferred to a bottle, 1,000 septems of water being used in rinsing the mixture into the bottle, and then 500 septems more were added, making in all 1,700 septems of water, and 630 grains of substance. The mixtures were generally made about the middle of the day, well shaken at intervals throughout the afternoon, and then allowed to stand to settle till the next morning, when as much as possible of the supernatant liquid was removed by means of a syphon. The solutions were turbid, but did not react with iodine. To 1,000 septems 100 septems of lime water were added, and the mixture was very slightly warmed to expedite precipitation, after which there remained a perfectly clear, but coloured supernatant liquid. Of this, 700 septems were taken for fermentation, and the remainder was left for the determination of the sugar by the copper method.

In the preparation of the extract from the malt dust some deviation from the above mode of procedure was made. In its case, 200 septems of milk of lime were added to 800 septems of the original infusion, and, after filtration, only 600 septems of the liquid were taken for fermentation, the remainder, as before, being left for the copper method.

From the above figures it results that the extract submitted to fermentation represented in the case of the malt dust, 177·9 grains, and in that of the barley, and of the other products of the malting process, 235·8 grains of original substance.

The yeast employed was pressed in a cloth, or between blotting paper, and then well mixed before being weighed out for use. Of the so prepared yeast 90 grains were employed for each fermentation; and two lots, of 90 grains each, were always mixed with water, and left to ferment side by side with the fermenting extracts, the whole being maintained as nearly as possible at a temperature of 78° F.

At the conclusion of the fermentation, each fluid was submitted to distillation, and the distillate was weighed in a 1,000-grain bottle, in successive quantities as it was collected, until the specific gravity showed that only pure water came over. The sum of the attenuation of the several separately weighed lots of the distillate, less that of the distillate from the yeast fermented with pure water, gave the total attenuation in 1,000 grain measures, due to the alcohol formed from the sugar of the substance experimented upon. The amount of proof spirit which 1,000 grain measures of spirit of the attenuation thus found, being ascertained by reference to Bate's Tables (and interpolation), it only remained to calculate the amount of alcohol which that amount of proof spirit represented, and then the amount of sugar (dry malt or grape sugar = $C_{12}H_{12}O_{12}$) to which the amount of alcohol was equivalent, thus:—

$$\frac{x \times 180}{92} = \text{Malt sugar}$$

II. *Determination by the Copper Method.*—A standard solution was made by dissolving, separately in water,—

245 grains of crystallised sulphate of copper,
700 grains of crystsllised tartaric acid,
840 grains of fused caustic soda,

mixing the solutions, and making up with water to 1,000 septems at 62° F.

According to calculation, on the assumption that 1 equivalent of grape sugar would reduce 10 equivalents of oxide of copper, 100 septems of this solution should indicate 3·535 grains or 1 septem ·03535 grains of grape sugar.

Another standard solution was made by dissolving—

242·98 grains of crystallised sulphate of copper,
700 grains of crystallised tartaric acid,
840 grains of fused caustic soda,

and making up to 1,000 septems. Of this solution 100 septems represented, by calculation, 3·506 grains, or 1 septem ·03506 grain of grape sugar.

The actual value of each of these solutions was determined from time to time by means of a solution made by dissolving 10 grains of pure cane sugar in 2 or 3ozs. of water, adding 20 or 30 drops of strong sulphuric acid (previously diluted), boiling for a short time to convert the cane sugar into grape sugar, and when cold making up to 500 septem measures with water. Each septem of this solution represented, therefore, ·02 grain of cane sugar, or

$$\frac{\cdot 02 \times 180}{171} = \cdot 02105 \text{ grain dry grape sugar.}$$

* From "Report on Experiments to Determine the Relative Values of Unmalted and Malted Barley as Food for Stock." By J. B. Lawes, Esq.

† 1 septem measure = 7 grains or one-onethousandth of a pound avoirdupois of water.

In testing the value of the solutions, or in actual working, 50 or 100 septem measures of the copper solution were put into a small flask, and heated by means of a water bath. The solution of sugar, or prepared grain extract, was then allowed to flow in by degrees from a burette, until the point of saturation was attained. Even with the solutions of pure sugar, it was difficult to determine by the eye, when the whole of the copper was precipitated, nearer than by one or two septems of the solution; and with the coloured grain extracts, the difficulty and range of error in reading, were of course increased. In practice it was found necessary, as the point of saturation was approached, from time to time, to remove a few drops, filter, and test by a solution of yellow prussiate of potass.

THE DEVELOPMENT OF PETROLEUM.

It is but a short time, some four or five years, since this oil was noticed flowing out of the ground in Venango, an obscure county in the interior of Pennsylvania, U.S. The demand was limited, and the supply suffered by indifference to its value. Flowing springs, and wells, were allowed to lie idle, or even abandoned, because there was then no market for the oil. Now, it is admitted, the more oil a well yields, the more does it suffer from stoppage or mismanagement, and incalculable damage may thus be done to producing localities. Those wells, which were formerly stopped by plugging, or otherwise, to prevent waste, have, almost without exception, resisted all efforts to renew their bountiful supply. They make up a considerable catalogue among the dry holes of the oil field. Now, wells are sought for, and they are worked day and night, not only in America, but throughout the civilised world, wherever the geologic stratifications induce the hope of success.

We referred to this subject in a former number, and now gladly avail ourselves of further information, which accumulates, concerning the strata peculiar to the deposit of petroleum, and other geologic indications of its locale. By making these indications fully known, we may spare the disappointment which might be the only result of seeking for oil in their absence.

Mr. R. P. Stevens communicates the result of his investigations to the "Mining and Petroleum Standard," from which we infer that the reservoirs of petroleum occur in "fissures in sandstone." This gentleman goes on to observe, that "the paleozoic, or sedementary strata, west of the Alleghany Mountains, have their important fissures, or shrinkage cracks, generally running with the magnetic lines, or, north and south; another at right angles; and the third perpendiculer to the above. There are also subordinate fissures crossing the others at various angles. By means of these fissures, the limestone and slate of the west, are easily removed from their beds in the quarries. The longitudinal fissures extend to a great distance. In the lead-bearing limestones of the Black River country, one of the fissures measured three-fourths of a mile across the entire plateau, and one in Virginia has been traced many miles.

The perpendicular fissures will often reach through the whole thickness of a particular series of rocks, forming chasms many hundred feet deep.

In the great bed of coarse, pebly, and fine grained sandstone, forming the base of the coal rocks of Pennsylvania, these fissures divide the rocks into immense *square blocks*, with spaces 10ft. 15ft. and even 40ft. between.

These fissures appear to have been former water channels, and have become filled with the residium of such drainage, and present us with veins of cemented sands, or of pure silex, or clays, or ores. There we have the iron ores of the trap rocks of Nova Scotia; also the veins of jasper, of spar, and of other minerals in the same rocks. Thus we see the veins of lead in the Shawangunk mountains, as the Erie and Ellenville lodes, and probably the gold, and silver mines of our western States and Territories. When the veins become filled with mineral, the course of water drainage is changed, being compelled to seek a new channel. We have examples also in the lead hematite caves of Missouri and the Galena region. One of the fissures, east and west, in the Alleghany mountains is referred to by Mr. J. P. Leslie, of Philadelphia. "There stands this vertical vein, running east and west, of solid petroleum, an evidence both of the abundance and antiquity of the Devonian petroleum."

A peculiar feature attending these perpendicular fissures, may here be noticed. In their downward extent they are most usually cut off by the intervention of a stratum of dissimilar nature, composed of different material. Thus, fissures of limestone will be interrupted by a thin layer of sandstone, or sandy shale; and in the great lead region of the upper Mississippi, sandstone always cuts off the veins of lead.

Another important feature of veins in mountain systems we will also notice.

It has long been established by M. E. Beaumont, of France, and Prof. C. Dana, of our country, that mountain ranges are upheaved, along great fissures of the rock strata of the earth, pursuing definite directions, according to the age of the upheaval; as, for instance, Alleghanies have a general north-east and south-west direction. In these mountains, all the main fissures will have the same direction, and the veins of iron ore, copper, and graphite, will obey the same law, while the subordinate fissures, will be at right angles, or north-west and south-east.

In the Shawangunk mountains, the course of the mountain is 20° east; the longitudinal fissures have the same direction, while the cross fissures run south 60° east, and north 60° west. The Galena veins of these mountains are in the latter system.

Besides the fissures already mentioned, there are innumerable others running horizontally with the strata, and minor cross tracks, due in part to shrinkage, and in part to repeated upheavals and down throws. These, when viewed separately, seem of minor importance; but, when viewed in the aggregate, become very important in the amount of any fluid they may hold, whether of gas, oil, or water.

When we stand by the side of any of the great oil wells of Oil Creek, as, for instance, the Empire, in its flowing stage, and see it flowing at the rate of 1,000 barrels of oil per day, for many months in succession, we naturally look for the natural reservoir, hidden in the rocks below, which is capable of holding such an immense quantity of fluid.

To the fissures in the third sandstone, must we look for this reservoir. Unfortunately, this rock is hidden 500ft. beneath the surface, at the point of penetration, by the bore of the Empire well. It is, therefore, impossible, at present, to descend into it; we must reason by analogy, or search for subterranean tanks where this rock comes to the surface. Fortunately, owing to the dip of this, and all the contiguous rock to the south: dipping at the rate of about 11ft. to the mile, by travelling northward and ascending the dip, we are enabled to find this sandstone coming to the surface. Accordingly, on French Creek we can see it, cut up by its innumerable fissures, so much, that it is difficult to find any very large-sized mass. In similar sand stones I have measured fissures 10in. 12in. and 15in. wide running many rods in linear extent.

The whole of the Devonian series of rocks, wherever seen in chasms, ravines, and river bluffs, is always cut up by the system of fissures already described. Now, *these Devonian rocks are traversed by those fissures which are our great receptacles of oil, whether in Canada or the United States.* Alluding to the quantity of fluid these cavities can contain, the writer already quoted, has so ably stated the subject, we shall continue to quote from him.

"Some of the main fissures are known to be 4in. wide. Suppose them of all sizes, from 4in., to a ¼in. in width, and at various distances, as from 5ft. to 50ft., and to be limited to the sandstone itself, say 30ft. in height; suppose we take the contents of the fissures to be equal to one five-hundredth of the mass of the rock. Now, supposing the oil to occupy but one-tenth of the space in each fissure, the remainder being occupied by gas and water, we have a yield of oil, to each square mile of sandstone, amounting to 50,000 barrels."

Another source of oil has been demonstrated by excavations in the oil-bearing sandstones of Ohio, and this is, the pores of the sandstone itself.

The rock is saturated with oil to that degree, that, it oozes out from open cuts, in sufficient quantities to become an economical investment to make deep and lateral excavations.

P. Sterry Hunt, of Montreal, has made some experiments testing the capacity of sandstones to hold water or other fluids. The mean of his results will give seven gallons per minute for thirteen years, from 1 square mile and 100ft. thick. From rock as porous as the oil-bearing rocks of Venango County, this quantity should be increased five-fold.

Every foot of gravel rock, may be considered to consist of three-fourths quartz, &c., and one-fourth cavity, occupied by water or oil. If we suppose only the uppermost 4in. of the whole formation charged with pure oil, that would give an absolute layer of oil 1in. thick, underspreading the whole country as far as the sandstone extends, or about 4,000 millions of square inches under every square mile; or, in other words 17⅓ millions of gallons, equalling 551,706 barrels.

When we consider that there are several sandstones thus charged—not less than fourteen, and possibly as many more—extending over many hundred square miles of territory, much of which has yet been unexplored, we may rest in the fullest confidence that petroleum, in its regular supply and permanent quantity, will not fail of becoming one of the most important mining enterprises of our country, as well as one of the most remunerative, to capital judiciously invested and economically expended.

NITRO-GLYCERINE.

The new blasting-oil Nitro-Glycerine, has been announced with all those claims on our notice which usher in novelties. How far these claims deserve our confidence, in practice, may be inferred from the few facts which have reached us. Nitro-glycerine then, is a light yellow, oily liquid; its sp. gr. 1·6. It is insoluble in water; it explodes only when in direct contact with fire, such as a lighted match. In point of fact, it will only explode under certain circumstances, and it then burns away leaving no residium. In favourable circumstances it possesses great rapidity of explosion, and can be kept for any length of time without losing weight or goodness. It detonates on being struck with a hammer; therefore, "tamping" it must be a dangerous process. It can be heated without danger to 212° F., but explodes at 356° F. It is poisonous, and causes violent headaches, which however soon pass off. It is stronger than gunpowder; because its decomposition affords a larger volume of gas. Although this gas will be of a higher temperature than gunpowder, under like circumstances, we can still get a greater effect. It has been estimated that nitro-glycerine is of thirteen times the strength of an equal volume of gunpowder, and at equal weights, it is eight times stronger than powder. There is a saving of labour when boring, as a smaller hole is sufficient. There is an economy over powder in relation to power, and also in relation to time employed in boring, &c. The absence of residium will be an advantage, when operating on rock salt. The great rapidity of explosion permits the nitro-glycerine to be used with advantage where rocks have many dislocations or joints, where powder would be wasted. There is claimed for it an absence of danger, when carrying or storing it. Solid tamping, it is said, is not required. Water presents no obstacle to its usefulness. All that is necessary is to pour this oil, by means of a tube, into the hole, and cover with water. The nitro-glycerine remains at the bottom, and the water above it becomes a sufficient tamping. It can rend large lumps of metal into fragments. It is necessary to use cartridges for horizontal holes, which, after all, should slope upward. The last we shall refer to is highly important to the miner. Whether it be the gases given off in the explosion, or particles of the oil which remain unexploded and distributed in the atmosphere, the result is such an effect on the nervous system, and respiratory organs, that headaches and at times vomitings, follow after the explosion, and therefore this nitro-glycerine may not be introduced to our mining operations. Above ground, the noxious fumes pass away readily, without inconvenience to the workpeople.

ELEVEN REASONS WHY THERE MUST BE CAVITIES IN THE CRUST OF THE EARTH.

By R. A. Peacock, Jersey.

(*From an unpublished M.S.*)

(*Continued from page* 77.)

The diagram given last month in connection with the 4th reason, requires a little explanation and correction.

The diagram, as transmitted, was drawn to the scale stated in the text, namely 1,000 miles to ⅛in. It was engraved, however (doubtless with the laudable object of economising valuable space), only on one-half that scale, but a proportional reduction of the thickness of the exterior line was inadvertently omitted. The line measures about $\frac{1}{150}$in. thick, instead of being only $\frac{1}{800}$in. When represented correctly, 10 miles by the scale would be only about equal to the average thickness of one of the interior lines, which materially strengthens the argument, so far as it depends on graphic illustration. Supposing, then, that the outer line were drawn of the average thickness of one of the interior lines, it would be 10 miles thick by the scale. And it must, therefore, be abundantly clear that a force, acting within that thickness, could not possibly cause undulations in the crust, if the latter extended downwards to either of the interior circles, and was a solid bombshell.

The following results may, perhaps, be accepted, provisionally and hypothetically at least, until further facts, corroborative or negative, can be obtained. The nucleus of the earth, has a uniform temperature of about 3,000° F. This is probably sufficient to produce saturated steam, having a force or pressure of about 900 tons per square inch. And that such force is powerful enough to account for any convulsions either of the coal period, or since. And, finally, that steam (assisted by other forces whose help is not essential) is the cause of all the natural disturbances of the earth's crust.

Note.—It is hoped that the series of papers "On the vast sinkings of land on the northerly, and westerly coasts of France, within the historical period" can be commenced in our next.

GUN PAPER.

Mr. G. S. Melland, of Lime-street, London, who has distinguished himself among our makers of firearms, has brought out a gunpaper to supersede our old gunpowder. So far as we can gather, it is paper impregnated with a composition formed of chlorate of potash, 9 parts; nitrate of potash, 4½; prussiate of potash, 3¼; powdered charcoal, 3¼; starch, $\frac{1}{12}$ part; chromate of potash, $\frac{1}{16}$ part; and water, 79 parts. These are mixed, and boiled during one hour. The solution is then ready for use, and the paper passed in sheets through the solution. The saturated paper is now ready for manufacturing into the form of a cartridge, and is rolled into compact lengths of any required diameter. These rolls may also be made of required lengths, and cut up afterwards to suit the charge. After rolling, the gunpaper is dried at 212° F.; and has the appearance of a compact greyish mass. Experiments have been made with it, and it has been reported favourably of, as a perfect substitute for gunpowder, superseding gun cotton and all other explosives. It is said to be safe alike in manufacture and in use. The paper is dried at a very low temperature. It may be freely handled without fear of explosion, which is not produced even by percussion. It is, in fact, only exploded by contact with fire, or at equivalent temperatures. In its action, it is quick and powerful, having, in this respect, a decided advantage over gunpowder. Its use is unaccompanied by the greasy residuum always observable in gun barrels that have been fired with gunpowder. Its explosion produces less smoke than from gunpowder; it is said to give less recoil, and it is less liable to deterioration from dampness. It is readily protected from all chance of damp, by a solution of xyloidin in acetic acid. The xyloidin is prepared by acting on paper with nitric acid, one part thereof being dissolved in three parts of acetic acid of specific gravity of 1·040.

Six rounds were first fired with cartridges containing 15 grains of gunpowder, and a conical bnllet, at 15 yards range, which gave an average penetration of $1\frac{1}{16}$ into deal. Six rounds, fired with 10 grains of gunpaper, and a conical bullet, at same range, and an average penetration of $1\frac{3}{8}$ into deal. Here was 33 per cent. less of paper than of powder, and greater penetration with paper. Six rounds followed with an increased charge of 15 grains of gunpaper, and a conical hullet, at the same range, and at each shot the bullet passed through a 3in. deal. At 29 yards' range 12 grains of the paper, fired from a pistol of 54 gauge (·44in.) sent a heavier bnllet throngh a 3in. deal. A fouled revolver was preserved four days, bnt betrayed no symptoms of corrosion after using gunpaper. It is expected that gunpaper will be manufactured cheaper than gunpowder.

We shall have a more elegant formula, no doubt, whenever our chemists turn their attention to this matter.

THE COMPOSITION, VALUE, AND UTILIZATION OF TOWN SEWAGE.

Since the appearance of our article in THE ARTIZAN of November last, "On the Deodorization and Utilization of Sewage," we find the following paper in the "Journal of the Chemical Society," by Mr. J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.R.S., F.C.S. It bears so strongly upon the points already dwelt upon by us, that we here give it in extenso:—

POSITION OF THE SEWAGE QUESTION.

It is no less true than strange that, after so many centuries of advance in regard to almost every other requirement of civilised life, the lesson should not yet have been learnt of how to dispose of the excretal matters of large populations, in such a manner as to secnre both their collection and removal withont nuisance and injury to health, and their economical ntilization for the reproduction of food. But it is undonhtedly the fact tbat, hitherto, where utilization has been the most complete, comfort and health have generally been in the greatest degree sacrificed, and where, on the other hand, the refuse matters of town populations have heen the most rapidly and perfectly removed from their dwellings, there has been either no utilization at all, or it has been most imperfectly attained.

Sewage, tbe foul stream which flows through the underground veins and arteries of our great cities, carrying witb it the excretal and other refuse matters of large populations, hitherto to little hetter pnrpose than to be wasted, and to be a source of pollution to our rivers—to destroy tbeir fish, injure their channels, and render them unfit as a water-supply to other towns—is the product of the, to us, modern, but in the history of the world only resuscitated and elaborated, water-system of town purification. There is no donbt that excretal and other refuse matters are removed from habitations more rapidly, with less nuisance to the occnpants, and with less injury to their health, by means of water, than in any other way hitherto practised on a large scale. But such is the dilemma into which the progress of modern civilisation in this direction has brought us in this country, so far as utilization and the condition of our rivers are concerned, that some authorities, especially on the Continent, incline to the reactionary conclnsion that a return to the cesspool system, or rather the adoption of some improved barrel, tank, or cesspool system, of collection and removal without admixture with extraneous water, is inevitable.

Before, therefore, entering upon the question of the composition, value, and modes and results of the utilization of dilute town sewage, it will be well to call attention, though very briefly, to some of the results of experience hitherto attained, under other systems of town purification, and other modes of ntilization of the prodncts, than the modern oues hy means of water.

China and Japan are frequently cited as affording examples of very perfect ntilization of human excretal matters, and, as a consequence, of great productiveness of the soil and great concentration of population on a given area of land. The manner of collecting, removing, and transporting buman excretal matters in those countries is, however, such as to he quite inadmissible with our modern notions of cleanliness, decency, comfort, and health.

It is frequently stated that in Belgium human excretal matters are very perfectly utilized, and realize considerable money return to the town populations. Indeed, in one of the applications made only last year to the Metropolitan Board of Works for the concession of the Southern sewage of the Metropolis, and still under the consideration of that body, it is stated that the excretal matters sell in Belgium for something over £1 per person per annum.

There is no doubt that in some parts of Belgium the solid, and a portion of the fluid excrements of the town populations are collected, as free as possible from extraneous water, in receptacles of more or less perfect construction, and periodically removed for application to the land, and that the land so fertilised is very productive. From observation and inquiry made in some of the towns in question, it may, however, be safely affirmed that the practices adopted are attended with, at any rate, so much of nuisance and discomfort as wonld not now be permitted in this country; whilst it would appear that a considerable proportion of the urine of the populations escapes collection and utilization. As the result of the same inquiries, it was conclnded that, in no case, did the town population realise by the disposal of their excretal matters as much as averaged one franc per head per annum.

The conclusion that, as a rule but little, and frequently nothing, is realised by town populations when their excretal matters are collected nnder more or less modified cesspool or tank systems, as free as possible from extraneous water, and so removed for application to the land, is fully confirmed by the results of an inqniry conducted by a Commission sent out by the Prussian Government in 1864, to investigate the modes of collection, removal, and utilization, in various localities, with a view to the adoption of improved plans for the city of Berlin.

Tbe Prussian Commissioners, Herren C. v. Salviati, O. Roder, and Dr. Eichhorn, visited and reported upon, not only the Belgium towns of Ghent, Ostend, and Antwerp, but likewise Hanover, Cologne, Metz, Carlsruhe, Strasburg, Basle, Lyons, Zurich, Munich, Nuremberg, Dresden, and Leipzig; and their report shows not only that the householders seldom realised anything like a franc per head per anuum for their excretal matters, but that in the majority of cases it cost tbem something for the removal. Nevertheless, looking to the position and local circumstances of Berlin, and especially to the resnlts of the water-system in this country hitherto, the Commissioners deprecate the adoption of that system for that city, and recommend more perfect arrangements and more stringent regulations for the emptying and removal of the contents of existing cesspools, and, where practicable, the adoption of a system under which the excretal matters of each house are to be collected in a barrel placed at the bottom of the shaft leading from the closets, which, wben removed, is covered with a closely fitting lid, and is of such dimensions that two men can carry it by means of handles attached for that purpose. They seem to anticipate little, if any, pecuniary profit to the town from these arrangements, hut consider that they will be attended with scarcely any, or even no, nuisance or discomfort, and tbat by their meaus a large amount of valuable munure will be provided in a convenient form for transport and utilization. There can, however, we think, be little doubt that under such a system the collection and removal must be attended with considerable nuisance, tbat the greater part of the urine will he lost, and that the cost of the collection, removal, aud transport will he such as to render the utilization unprofitable heyond a comparatively limited distauce from the city.

There is little probability that the difficulties of the water-system will lead us in this country to have recourse again in our large towns to any system of cesspools, tanks, or barrels, however improved; but it may be well here to notice one or two attempts that have heen made within the last few years to obviate the use of water, and thereby avoid the pollution of rivers, and to secure the collection of the manurial matters in a form more readily transportable by ordinary means, and, therefore, more applicable for general agricultural use: for there cannot he a doubt that if any system could be devised by which human excretal matters conld be collected and removed from dwellings, without either nuisance or injury to health, and obtained economically in a concentrated, dry, and portable condition, their utilization would be much more perfectly attained by such meaus than is at all likely, or even possible, under tbe water-system.

Perhaps the most noticeable attempt of the kind in question is that which has been made at Hyde, in Lancashire, a manufacturing town of more than 20,000 inhabitants. Some few years ago a company contracted to carry out what they call the "Eureka system." They provided boxes to fit in at the back of the privy or closet of nearly every house, leaving scarcely a water-closet in the place. Some disinfecting or deodorising mixture is put into the hox before it is placed in its position, and the box is exchanged for a fresh one after a certain number of days, according to the number of individuals frequenting the place; and it is stipulated that neither extraneons water, nor any other than human excretal matters, should be accumulated in these receptacles. The boxes, wbcn removed, are covered with closely fitting lids, and so transported in closed vans to a manure manufactory close to the town. Here the matters are first well mixed, and then strained to remove rags, which are washed and sold for paper-making. More disinfectant is then added, and the matter concentrated by distillation, the distilled waters being sold to dyers and bleachers. The residue thus thickened is then mixed with coal-ashes, which are collected in the houses in casks left for that purpose, and before being used are re-burnt in a reverberatory furnace, and finely ground.

On visiting Hyde in 1863, it certainly appeared that the mode of

collection and preparation adopted was attended with, at any rate, very little unpleasant odour, and it was maintained by the advocates of the system, that its adoption had been successful in a sanitary point of view; though even at that time some difference of opinion existed, and a controversy on the subject was in progress. The system is still in operation; but we are informed that the feeling of the inhabitants is very strong against the maintenance of the works in the neighbourhood; indeed, that an injunction against them has been sought, though unsuccessfully, and that proceedings by indictment are now being taken. This opposition has reference not to the mode of collection, but to the conducting of the manufacture so near to the town. But, whether or not, the plan of collection and removal may have proved successful, so far as the avoidance of nuisance and injury to health are concerned, the process of manufacture seems, unfortunately, to offer but little prospect of successful utilization, so far at least as can be judged from the results of an analysis made at Rothamsted, of a sample of the manure obtained direct from the works. It was found to contain only between 1 and 2 per cent. of ammonia. Such a manure, although it might be useful enough when applied in quantities of many tons to the acre, would obviously be not worth more than its carriage beyond the distance of a very few miles. Besides the great dilution of the more valuable manurial matters by the admixture with ashes, a little consideration of the habits of the people is sufficient to account for the small quantity of ammonia found in the manure; for it is obvious that little of the urine beyond that passed once a day with the fæces would reach the boxes, and so find its way into a manure thus collected and prepared.

One more dry system, the offspring of the difficulties of the wet one, should be briefly noticed, namely, that of the Rev. Mr. Moule. Mr. Moule has invented and patented an arrangement for the use dry sifted earth, instead of water. He states that by the use of about 4lbs. per head per day of finely sifted clay, deposited by means of a mechanical arrangement upon the fæcal matters as soon as passed, they are at once entirely deodorised, and in a few weeks are so entirely disintegrated that neither excretal matters nor paper can be detected in the mass, which, he says, looks and smells like fresh earth, and may, after resifting, be re-used, until it has done duty four times over, by which, of course, there is not only a great saving of material, but the value of the manure is considerably increased.

Very obvious objections to such a system are—the difficulties of the supply and preparation of the soil in the case of towns, or even in the country in wet seasons; the fact that but little of the urine, containing as it does so large a proportion of the valuable manurial constituents of human excretal matters, would reach the compost so prepared; and that in the manure produced, the more valuable matters would be diluted with so large a proportion of comparatively useless material, that beyond a very short distance the cost of carriage would be all that the manure was worth. On the other hand, that the adoption of such a system would be a great improvement in a sanitary point of view, in the cases of sick rooms, detached houses, or even villages, where the water-system is not available, and that it might be even economical where the earth for preparation and absorption, and the land for utilisation, are in close proximity, may, perhaps, be readily granted. But we are certainly not so sanguine as the Rev. Mr. Moule, who seems to think that with the aid of earth-closet companies, his plan is as practicable for large towns as is the supply of water, gas, and coal, at present, and much more so than the removal and utilisation of dilute town sewage.

Whilst it must be admitted that the agricultural utilisation of human excretal matters has, hitherto, been much more completely attained under the system of collection without water than under our new one with it, it must not be forgotten that neither on the continent of Europe nor in this country has such utilization resulted in any substantial profit to the town; and that it is, with the recorded results of China and Japan before us, and after so many centuries of experience nearer home, of at least comparatively successful utilisation, that the old systems have been abandoned, as utterly inconsistent with advance in habits and notions of cleanliness, and with the maintenance of the comfort and health of large populations. Nor do the modifications of the dry systems, to which reference has been made, seem to hold out any hope of general and permanent applicability to large populations, looking, as we must, to the combined requirements of convenience, comfort, health, and utilisation. Our water-system of house defecation and town cleansing is, on the other hand, scarcely more than a generation old. By its means excretal and other refuse matters are more rapidly removed from dwellings than is possible by any other; and, independently of the increased comfort and freedom from nuisance obvious to all, sanitary statistics have abundantly shown increased immunity from zymotic diseases, and increased longevity, as the result of the adoption of that system. True it is that these advantages have, hitherto, been attained at the cost of the almost universal sacrifice of the manure, and of great injury to our rivers.

This, then, is admittedly the existing dilemma of our modern practices. But public attention is now so thoroughly directed to the subject, that little fear need be entertained that either the systematic non-utilisation of the sewage, or the pollution of our rivers by it, will long be permitted. Least of all is it reasonable to find discouragement in the fact, that the system which has done so much for some of our town populations in so short a time, should not, at this early stage of its trial, have accomplished all that might be desired, or to conclude that the nuisances and difficulties incident to the old plans, which have remained unremedied through so many centuries, have much better chance now than formerly of being successfully obviated.

Assuming that there is more likelihood of the general applicability, success, and permanence of the water, than of any other system of urban defecation, it becomes important to consider the composition, the value, and the modes and results of the utilisation of the product of that system, namely, *dilute town sewage.*

More plans have been proposed for the separation of the valuable constituents from sewer-water, and the manufacture of them into dry and easily portable manure. But whilst several of these plans have been successful in separating the whole of the insoluble or sedimentary matter, and even some portion of the soluble constituents, leaving the fluid to a great extent, or at any rate temporarily, purified, and in a much less objectionable condition for turning into rivers, none have succeeded in either adequate or permanent purification, or in the separation of the more valuable manurial matters, and the production of a concentrated solid sewage-manure, having a sufficient value to be remunerative, and to bear the cost of transport more than a few miles;* nor when we consider the great solubility of some of the more active manurial constituents of sewage, and the great dilution of them in the sewage, can any hope be held out of so desirable a consummation;—desirable, indeed, for if human excretal matters, the residue of the constituents consumed as food, cannot be recovered in the form of a concentrated, dry, and easily transportable manure, little hope can be entertained of their redistribution over anything like the area from which they came, or of their general use for the direct reproduction of the varied descriptions of food which were their source.

The questions arise: What is the amount, and what approximately the money value for the purposes of manure, of the constituents contributed to sewage by a given population? What their state of dilution in sewer-water? To what soils and crops is dilute sewage the most applicable? What is the money-value realisable in practice by sewage utilisation? What are the conditions of profit or loss to towns of such utilisation?

Composition and Value of Town Sewage.

It is one thing to determine the amount of constituents contained in sewage, or contributed to it by a given population, and to estimate their value accordingly, as if they existed in the dry and portable condition of the various concentrated manures of known value in the market; but it is obviously quite another to settle the really available or realisable value of the same constituents when they are distributed through an enormous volume of water, and if they must be transported and utilised in that condition. Let us first consider what may be called the theoretical value of the constituents of sewage, or their estimated value, taking as the measure the value of the same constituents in dry and portable manures.

Numerous authorities have undertaken the consideration of this question, and two chief methods have been adopted. One of these has been to take samples of sewage and determine its composition by analysis, to adopt such estimates as are at command relating to the amount of sewage available within a given time or from a given population, and so to reckon the amount and value of the constituents in a given quantity of sewage, or per head, or for a given number of persons, per annum. Another is to base the calculation upon the amounts of fæces and urine, or of the various constituents of these, which have been recorded as voided by individuals of different sexes and ages—sometimes making allowance, and sometimes not doing so, for other than human excretal matters reaching the sewers.

First, as to the results attained when the calculation is based upon the analysis of sewage, and estimates of the amount of it yielded by a given population.

In estimates of the value of the constituents of sewage, about three-fourths of the total value has generally been attributed to the ammonia (or nitrogen reckoned as ammonia); and it so happens that if a value of 8d. be put upon every lb. of ammonia shown by analysis to be contained in sewage, or if for each grain of ammonia per gallon, a value of one farthing be given to the total constituents in 1 ton of the sewage, the

* For information in regard to some of the plans proposed for the partial purification of sewage-water, or for the separation of a solid manure from it, see—"On the Application of Sewage to Agriculture," by Dugald Campbell, Esq., F.C.S., Chem. Soc. Qu. J. vol. x., p. 272. "Report of Chemical Investigations relating to Metropolitan Main Drainage Question," by A. W. Hofmann, LL.D., F.R.S., and Henry M. Witt, F.C.S., "Report on Metropolitan Drainage, 1857." "Deodorisation of Sewage, Second Report of the Royal Sewage Commission, 1862," Appendix No. 6, p. 64.

result will, in either case, agree almost exactly with that obtained by the elaborate method of giving the currently adopted market values to the several constituents, taking dry and and portable manure as the standard.

One or two illustrations may be given of the applicability of the latter mode of reckoning. In the summer of 1863, Baron Liebig, adopting as the basis of his calculations an analysis of the Dorset-square sewage by Mr. Way, which showed nearly 18 grains of ammonia per gallon, estimated that (provided the quantity of phosphates which he considered requisite to render the whole of the ammonia available were employed with the sewage) the constituents in 1 ton of sewage of that composition would be worth about 4d. Now, according to our mode of estimate stated above, 18 grains of ammonia per gallon would indicate a value of 18 farthings, or 4½d., for the total constituents in 1 ton of the sewage. In January, 1865, Baron Liebig assumed the average sewage of the metropolis to contain only 7·2 (instead of 18) grains of ammonia per gallon; and he estimated the value of the constituents in 1 ton of such sewage to be rather over 1¾d. Our estimate would also give rather over 7 farthings, or 1¾d. Lastly on this point, in 1857, Messrs. Hofmann and Witt concluded from their investigations that the average dry weather sewage of the metropolis contained about 8·2 grains of ammonia per gallon; and calculating the value of the sewage according to the amount of ammonia, organic matter, phosphoric acid, and potassa, they estimated that of the total constituents in 1 ton of such sewage to be about 2·11d. It is clear that giving a value of ¼d. to the total constituents per ton of sewage, for each grain of ammonia per gallon, would yield almost identically the same result.

It is obvious, therefore, that in this part of the discussion we may, for all practical purposes, safely disregard everything but the amount of ammonia contained in the sewage, and that by so doing the consideration of the subject will be greatly simplified. It will be seen, too, that in adopting this course we do not in any way ignore, or undervalue, the importance of the associated constituents, but on the contrary, accord to them the same value as Baron Liebig, Messrs. Hoffman and Witt, and others, have done by a much more elaborate process of calculation.

(To be continued.)

THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.

Since our last we have received the prospectus of this newly-formed association, under the auspices of several of our most distinguished men of science. The subject of aerology and aerial navigation is one which for some time past has attracted so much attention that we are glad to find a special scientific body formed, as stated in the prospectus :—

"To foster and develope the science of aeronautics which has stagnated for so many years, and incidentally therewith to increase our knowledge of aerology, are the objects of this society.

"Its formation is due to some suggestions made at the late meeting of the British Association at Birmingham.

"In the hands of private individuals the progress made in aeronautics has been for any useful object almost *nil.* The great expense attending the necessary experiments combined with the absence of scientific and mechanical attainments on the part of aeronauts generally, considered in conjunction with the fact that their baloons were often in profitable requisition for purposes of amusement have doubtless contributed to the present uninteresting and unsatisfactory condition of the science of aeronautics.

"There are, however, a great host of believers who have hoped much from the conjunction of educated science with balloon pioneering, and the council of this society are encouraged to believe that they will be supported in their efforts by the contributions of well-wishers.

"Accordingly they propose :—

"1st. To admit to membership upon payment of an annual subscription of £1 1s., and to appeal to the public for donations.

"2nd. To rent ground and construct balloons and apparatus for experiments.

"3rd. To conduct experiments in aerology in conjunction with aerial navigation.

"4th. To establish a museum for the collection of all models and inventions of man in his endeavours to elucidate the practicability of aerial navigation.

"5th. To furnish subscribers with tickets of admission to the grounds upon public days of experiments, and to issue a Periodical of transactions and intended experiments.

"To issue tickets for a seat in the car upon one of the days of ascent, the determination of which will take place by ballot amongst those subscribers who shall have sent in their names previously for that object.

"In a shed constructed for the purpose it will be possible always to maintain one of several balloons inflated ready for ascension, and if it were needful, and the society possessed of sufficient members, an ascent might be made every day at a certain hour (weather permitting).

The following is the Paper read by the Hon. Sec., Mr. Fred. W. Breary, at a council meeting of the Society, held at Stafford House, His Grace the Duke of Sutherland, Vice-President, in the chair:—

It appears necessary, in view of checking the superabundance of schemes for aerial propulsion which are likely to claim the attention of the Council, that some mode of operation should be determined upon and published. This is the more necessary because from the infancy of the Society it would not be possible to enter into any expensive experiments, however promising they might appear, and it would save much disappointment to inventors, besides enabling them to exercise their ingenuity in a direction consonant with the intentions of the Council, if it were declared at once what experiments the Society, in consideration of its limited funds, would be inclined at the commencement to aid.

It will not be out of place here to say that in the formation of this Society I had the simplest object in view, feeling that, although the time was favourable for a movement, it was not safe to encourage the idea that any extravagant notions were contemplated. Indeed, I hold the opinion that although much will be accomplished, and that the pleasure and gratification of mankind is on the eve of being greatly enhanced, and although explorers in distant parts of the earth will be greatly assisted, and, consequently, that the general knowledge of mankind will be increased, yet that, as a means of conveyance, no improvement in aerial locomotion can ever compete with ship or rail

Impressed greatly with the belief, that holding moderate views, an Aeronautical Society would be supported even by those who had made all preceding attempts a subject for ridicule, I went down to Birmingham, by the advice of Mr. Glaisher, to make certain simple suggestions at the meeting of the British Association, and at that meeting the nucleus of the Society was formed.

Dr. Fairburn, when asked to join the Council, expressed an opinion that the objects of the Society were Utopian, but upon repeating to him the substance of the suggestions made at Birmingham, he consented to act. Those suggestions were founded simply upon the accomplished results of a machine capable of floating in the atmosphere, whose course was guided entirely by the direction of the wind, and the well-known fact that different currents are met with at uncertain elevations, and even to the extent of opposite points of the compass. To make our floating machine more useful, it is necessary to invent some plan by which it may ascend and descend, without loss of gas or ballast, and so move into those currents which are favourable to the desired course.

Those currents may possibly be found more regular than is imagined, and it is only by repeated ascents with that object in view that the truth can be ascertained. No elaborate or expensive machinery will be required for the object advocated, and its successful achievement will economise the consumption of gas, and save the great weight of ballast otherwise necessary to take it up.

To aid this object there will naturally follow improvements in the varnish for balloons, so as to render them impervious to the gas, as also a mode of fastening down the balloon to the ground in a manner least resistant to the wind when it should become necessary to anchor.

In the French war balloons, a cover was thrown over all, and strongly fastened to the ground, so that, in fact, an inclined surface was presented to the force of the wind in every direction.

This simple object of ascent and descent by the assistance of mechanical power has been greatly overlooked in the more ambitious attempts at propulsion. In consequence, there have been proposed the most elaborate arrangements of machinery and motive power which require machines so vast in dimensions as to be unmanageable upon land, because, upon so great a surface, the lightest breeze produces an embarassing effect.

The power required to raise an object which already possesses buoyancy is very slight compared with that which is requisite to propel against a resistant atmosphere.

The effect also of the more simple power would be incomparably greater, because upon the supposition that a balloon required an additional power of 20lb. beyond the gas with which it is inflated to raise it into the air, the application of a slight mechanical arrangement will clear it above all obstructions, and bring it under the influence of another power, which will give it horizontal direction, and if that direction be not the one desired it will raise it in search of another. The cessation of this mechanical action will also bring the balloon down to the ground.

Apply this power, equal to 20lb., to a propeller, and its inadequacy to effect any satisfactory result in a horizontal direction becomes apparent.

I have no doubt that horizontal propulsion has been attained upon several occasions, some of which have been recorded, but always with so insignificant an effect compared with the space to be traversed, that no importance has ever been claimed for success.

Not so, however, where vertical effect has been accomplished, for there are numerous instances where such means as the aeronaut could use from the car, have been tried with success, so as to enable him to alight gently, or to clear trees, mills, and other obstructions.

In other words, one mile gained in a horizontal direction against an opposing or oblique wind would be gained with much greater expenditure of power, which would necessitate a larger balloon, than one mile in a vertical direction, during which it might be possible to acquire the desired course by reaching a different current.

In the former case the advance of one mile would scarcely be appreciable but in the latter is included safe anchorage and the command of more than one direction of voyage.

Mr. Green, the aeronaut, has been the recipient of more suggestions upon this subject than perhaps any other man, and he still holds the same opinion, as is recorded in an article extracted from the *Westminster Review*, as follows :—

"The want of success attending the early attempts at guiding balloons appears to have deterred adventurers from repeating those experiments or devising new methods for effecting this object, and since the beginning of the present century nothing of practical utility has been tried.

"However, Mr. C. Green, whom we have already had occasion to mention, has broached an idea which appears to be in the right direction, and which will possibly, when modified, be found to be feasible.

"Mr. Green having remarked during his numerous balloon voyages that at various heights above the earth he met with currents of air which carried him

in a direction differeut from that in which the balloon was blowing at the time of starting, conceived the idea, if it be possible, to keep a balloon at a constant elevation above the surface of the earth, that advantage might be taken of this circumstance, for by increasing or diminishing the altitude of the balloon a current of air might be found to carry the aeronaut in any direction he might desire.

"It has indeed been long known that the wind observed at the surface of the earth does not blow in the same direction as the current of air moving at some distance from the earth. This phenomeuon occurs not only in our latitudes but also in the regions of the trade winds; and several observers, amongst them, Sir James Ross, in his recent voyage, have noticed when in the trades small clouds moving at a considerable height above the sea, in a direction contrary to the trade winds. It is obvious that, if it be true, that at some considerable height above the sea we may find a wind blowing in any given direction, and supposiug we can cause the balloon to remain invariably at the same height, we may be euabled to move a balloon in any direction merely by ascending and descending until a current of air having the required direction is met with. Various methods of causing the balloon to remain at an invariable height may doubtless be supposed, but the one actually in use, that of discharging gas and ballast according as it may be necessary to check a tendency of the balloon to rise or fall, is of very limited application, for the quantity of ballast and gas which can be employed in this manner is very small.

"The power of varying the elevation or remaining at the same height, would be greatly extended by the use of the condensed or liquefied gas.

"A small receiver containing liquefied coal-gas might be taken up in the car, and being connected with the balloon by a tube and stopcock, the aeronaut would be able by the simple agency of the stopcock, to permit the entrance into the balloon of a large quantity of gas.

"There will uudoubtedly be a few practical difficulties in its application, but none such as could not readily be overcome; but the danger attending the use of gas in this form is but slight, liquefied gas having been in common use for some years past for lighting apartments and railway carriages in France."

Thus far the *Westminster Review*. Mr. Glaisher's observations upon the different air currents prevailing in the atmosphere confirm these and all previous accounts.

But with further reference to Mr. Green, I may observe that, as regards the sea, his method of crossing it at an uniform elevation by means of the guide rope was successful, but as this would be atteuded with danger upon land it is necessary to substitute some other method, especially as the range of his ascending power was small.

Contrary, therefore, to all previous efforts I propose that the balloon should be used as a buoyant power merely, and that what it wants in ascensive power should, in the absence of any chemical arrangements, be supplied by mechanical means, which should be of such power in proportion to the number of cubic feet of gas, that by its exercise iu an opposite direction it would be able to oppose and reverse any ascensive power gained by the sudden rarefaction of the gas, or on the other hand any condensation which might cause it to descend. There is every probability that such a power could be exerted by a man with appliances disposed about his person, and as there appears to be no doubt that men have actually succeeded in flying to some extent, although meeting with grief at last, it would be advisable in auy future attempt to use gas as a buoyat power as au swimmer uses corks, until he should grow confident in the use of his apparatus.

One of our council, Mr. Butler, has constructed a pair of wings to operate from the car of a balloon, the downward blow of which is calculated to strike with a force exceeding 40lb., and I believe that it will be able to exert that force, which would be about equal to the asceusive power of 1,000 cubic feet of carburetted hydrogen.

The action required is somewhat similar to that of rowing, and would be exactly so, if at the cud of the stroke, the oars sprang backwards out of the hands of the rower; but in this case the body is stretched forward, as if towards the stern of the boat, to grasp the haudle and repeat the process, during which it is necessary to say that an action eqivalent to feathering is obtained. It is to be anticipated that these wiugs, acting from a pendulous fulcrum, will produce, in addition to the object for which they are designed, two effects, which may possibly be hereafter modified, but which will be unpleasant accompaniments to a balloou ascent, viz., the oscillation of the car, aud a succession of jerks upwards, first communicated to the car from below, and repeated immediately by au answering jerk from the balloon.

Those who iuspect this mechanical adjunct of Mr. Butler's can scarcely fail to be pleased at the simple arrangements by which so forcible an impact is directed. The effect of such contrivance, if Mr. Butler can show that these objections are unfounded, will be a mode of securing ascent and descent without loss of gas or ballast, and possibly of horizontal motion also, upon the principle suggested by his Grace the Duke of Argyll, in an article published in "Good Words" for February, 1866. It would represent a mechanical substitute for about 1,000 cubic feet of gas, and if the movement were capable of being reversed would also represent about 40lb. of ballast. As at present constructed, however, its action upon a balloon wanting the addition of 40lb. to its ascensive power will certainly have the effect of raising it from the earth clear of all obstruction, and unless by any sudden rarefaction, exceeding in amount the power of the mechanical arrangement, the balloon must descend by mere cessation of the downward stroke. The descent may also be regulated in a more agreeable manner than usual without the sensitive tendency to rise at the moment of coutact with the earth.

As to the disposal of the wings and the prospect of the balloon becoming entangled in them, and otherwise injuring them, I will not now further allude; but it is evident that repeated ascents may be made without replenishing with gas.

Another object which the Society might beneficially publish as a desideratum would be the best mode for the manufacture of gas in emergencies; and here I would remark that the absence of a balloon corps in our army has not been satisfactorily explained, although the authorities have instituted inquiries with that object. The evidence adduced to their disadvantage is no more conclusive than that which would warrant us iu discontinuing the use of the fire-engine because of the number of fires in which it is inoperative.

But the fact is that the salvage from the least calamitous fire may be trifling in comparison with the advantages which might be gaiued by one successful observation of an enemy's position.

One success may compensate for a hundred failures. The *Times*, for instance, of April 14, 1862, reports of the Federal Americaus thus:—"A balloon recognisance was made on the 27th March by Professor Steiner, accompanied by Col. Burford and Captaiu Maynardier, which established the fact that shells had been thrown at too great a range to be sufficiently effective against the Confederate batteries. This defect in mortar practice has siuce been remedied." "And," says the author of 'Astra Castra,' in summing up the advantages of balloons in warfare, "I think it may be adduced, from the foregoing historical account, that a very fair average of success has attended the use of recounoitering balloons by different armies during the last seventy years." If, therefore, this Society aim at national acknowledgment, it will not neglect experiments upon the manufacture of gas in a portable, ecouomical, and expeditious manner; nor would an application, I should imagine, for assistance to the proper authorities for this and its kindred object be ineffective. That the balloon, even in its present form, has been a great adjunct to science, quite apart from its exhibition as a toy, the following remarks, made very lately by De Fouville, in France, sufficiently attest. He says:—"Without Mr. Glaisher's ascents we should not know that the law of progressive refrigeration is not found to hold good at great altitudes, or that in the air there exists a sort of Gulf Stream, if we may be permitted to call them so, consisting of hot air, and affording an easy explanation of the irregularity of the seasons." And, after alludiug to other advantages, he says:—"It is not, therefore, possible to assign any limit to the utility of aerial navigation, as it is now practical by the labours of distinguished philosophers."

It will, therefore, become necessary that the Society should possess a balloon of such size as to afford, wheu slightly iuflated, a buoyant aid to inventors, and otherwise an opportunity for further investigatiou as to air curreuts and other phenomena connected with the science.

It is not at all a necessity that the expense of these experiments should be borne by the Society; for if we hold out eucouragement to iuventors by the aptitude and readiness of the Society's arrangemeuts, it is very probable that iuventors will pay the expeuses of aerostation, which advantages have never yet been afforded.

If the Society be sufficieutly successful in a pecuniary sense to possess premises, various experiments may be made with captive balloons, not alone for military observations, but for determining the daily temperature of the air at elevations ordinarily beyond the hope of attainment. It would also be desirable that our members in different parts of the country should make daily observations of the clouds, and of their diverse direction at varying elevations; and for this object such of our members who will undertake these duties should be provided with forms which should show, when filled up, the course of the lower, middle, and upper strata of clouds at given moments of time.

At a meeting of the Council of this Society, held at Stafford House, St. James', on Tuesday, the 17th ult., James Glaisher, Esq., F.R.S., in the chair, the following new members were announced:—Messrs. Robert Holland, Stanmore, Middlesex; Charles Carttar, Coroner for Keut; William Frederick Harrison; F. M. S. Bartropps, Weybridge; Thomas Dick Sanders, 60th Rifles; A. J. Melhuish, F.R.A.S., York-place, Portman-square. Messrs. Hatton Turnor (author of "Astra Castra"), and Henry Wright (nominated by his Grace the Duke of Argyll) were elected members of the Council.

Mr. F. W. Brearey, the hon. secretary, read a paper, contributed by William Fairbairn, Esq., LL.D., advocating perseverance in meteorological experiments, with a view of increasing our knowledge of "the law of storms aud of electric and magnetic phenomena, which enter so largely into the movements of elastic fluids wheu united to vapour and heat in the shape of clouds."

Mr. Butler contributed some interesting facts as to the progress of the science in France, gathered in his visit to Paris since the last meetiug. Some discussion ensued as to the feasibility of an exhibition for a short time in London of the various models which illustrate the mode of ascent into the atmosphere without the aid of balloons, aud Mr. Butler undertook to communicate the views of the Council to the French societies, so that the inventions of both countries might be collected in oue exhibition.

It was arranged that the first experimeuts under the auspices of the Society should take place next month, conducted by Mr. Glaisher, F.R.S., and Mr. Westcar, of the Royal Horse Guards, wheu, in addition to observations of a meteorological nature, some experiment specially adapted to the confirmation of a theory as to the flight of birds, by Mr. Wenham, C.E., should be attempted from the car of the balloon.

A general meeting of members was advocated at as early a date as should be warranted by the value of the information to be imparted to them.

The Secretary announced the following donations:—Colonel Morriesoii, £5 5s.; Henri Reda St. Martin, £11; and Mr. Potter, £11.

"An Excursion to the Crewe Locomotive Works," by J. J. Birckel. Crank cutting lathe. Illustrated by plate 300. The plate given herewith, is that promised in our last, in illustration of the crank cutting lathe therein fully described.

ON SAFETY VALVES FOR STEAM BOILERS.

The following is the substance of a paper recently read by Mr. George Campbell, before the Leeds Association of Foremen Engineers, upon the important subject of safety valves for steam boilers :—

Soon after steam pressure began to be used in the arts and manufactures, it became evident that some means must be devised for securing the safety from explosion by over-pressure of the generators employed in raising the steam necessary for carrying on the diversified work which the genius and ingenuity of man required at its hand.

Such a guardian we have, to a great extent, in the appliance known as the safety valve. This contrivance, nearly in its present more common steelyard lever form, is said to have been invented by Dr. Papin, in 1684, as an appendage to his apparatus for dissolving bones by steam pressure; but its first application to steam boilers, or generators for the steam engine, is said to have been made by Savery.

Since those days of mechanical dawnings, when our forefathers, as pioneers, had to feel their way step by step, down to this scientific age of ours, the safety valve on our steam boilers or generators has had spent on its improvement (or so-called improvement) a large amount of time, material, and money; for what with single and compound, mercurial, equilibrium, fusible alloy, direct loaded, magnetic, and a host of others, one cannot but think that safety valves (and some of them might with all safety be called danger valves) have received their share of attention at the hands of the engineer. Yet even at the present day the perfection of the safety valve still remains more a matter of opinion than fact.

In looking over the reports of the Inspectors of Associations for the prevention of Boiler Explosions, boiler assurance, &c., one cannot but observe the frequent complaints made against the safety valves on boilers under inspection. Some loaded with extra weights, such as bricks, stones, broken metal, &c.; others inoperative from neglect of cleaning, or sticking by friction, while some in the most reckless manner are bolted or wedged down, and thus rendered intentionally inoperative; and, incredible as it may appear, not long since, a boiler was found working without a safety valve. On the criminality incurred being shown to the owner, he answered, he intended to attach a valve, but being undecided which kind to fix, he had, in the meantime, allowed his boiler to work, the pressure of steam being regulated by the pressure gauge, a poor guardian, we must all say, with water in the boiler and fire under it, and no human eye present to watch the movements of the steam guage. There are certain qualifications which a good safety valve ought to possess, and the principal of which are simplicity in construction, a free and sufficient exit for the steam,—by this we mean one that will not allow the pressure in the boiler to exceed the weight on the valve; further, not to be liable to become inoperative from sticking by friction, through pins and rubbing surfaces; and above all, to be if possible, beyond the reach of tampering with the weights by the hands of the ignorant, the malicious, or the reckless. It is a pity we have still to deplore, as we have seen, that men are to be found, who either from ignorance, malice, recklessness, or to gratify some peculiar propensity, endanger their own and the lives and property of others by tampering with the levers and weights of the valves placed under their control.

An improvement on the ordinary form of lever valve is that patented by Mr. William Naylor, of London, a gentleman well known in the engineering world by his assiduous endeavours to further mechanical science; but, perhaps, better known in the neighbourhood of Leeds by his arrangement of steam hammers, made by the Kirkstall Forge Company, and largely employed in the manufacture of iron by our principal forges in this and foreign countries.

Tredgold, in his able and valuable work on the steam engine, says :— "It would be a great improvement on safety valves if they could be so constructed as to be relieved of a part of their load when raised from the seat." Safety valves, as generally loaded with a spring balance, especially on locomotive, portable, or other boilers subject to oscillation, instead of complying with Tredgold's sound observation, have a contrary effect when rising from their seat, increasing to a serious extent the load on the valve and strain on the boiler, which, no doubt, most of you have observed when looking at a valve blowing off, compared with the pressure shown on the pressure gauge—a difference in excess, on the valve, of 20 pounds per square inch (sometimes more) being a common occurence, if the fire under the boiler be urged, and the steam so generated not drawn off by any other medium than the safety valves.

This can be easily shown by calculation; take for example :—a valve, 4in. diameter, equal to an area of $12\frac{1}{2}$ square inches, consequently the lever must be $12\frac{1}{2}$ to 1, for one pound on the end of the lever, to give one pound per square inch on the valve. Taking the angle of the valve seat at 45°, it will be found that the end of the lever, where the spring balance is attached, must be raised half-an-inch to obtain an opening at the valve of ·3351 of a square inch, an opening not equal in area to a round hole $\frac{11}{16}$ths of an inch in diameter. Then, if we take the graduated range of the spring balance at 30lbs. per inch, it will be clear that by raising the lever half-an-inch at its end (to obtain even the above small opening), an additional pressure of 15lbs. per square inch is put on the boiler by the tension on the spring balance; there is besides this extra load by the balance, friction by the joint pins in the lever, and friction caused by the steam issuing through such a small opening. These, with the resistance of the atmosphere, have the effect in causing a great amount of needless pressure on the boiler, when the steam is blowing off strong at the safety valves. A theory has been advanced to account for the small rise of the valve from its seat, thus;—"That by the instantaneous reduction of steam pressure under the valve, so soon as an outward current has been established, motion takes the place of dead pressure, consequently the pressure in the boiler sometimes rises dangerously above that to which the safety valve is loaded." A valve has been designed to supply the defect pointed out by this theory, and shown in the Exhibition of 1862, by Mr. Bodmer, of London; a section of his arrangement is shown by the annexed woodcut (fig. 1), and the action of his valve is described as follows:—"The full boiler pressure is maintained upon the underside of the valve, entirely separated from the current of steam blowing off. For this purpose the valve cap is turned out on the underside, so as to form a cylindrical recess, to receive a steam-tight disc, projected from the valve seating; the valve seat, or opening for the escaping steam, being below the level of the disc. Steam or water from the boiler is admitted, under pressure, through a central tube to the space between the disc and the top of the valve, and is thus kept separate by the steam-tight disc from the escaping current of steam below."

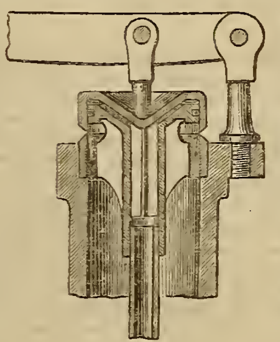


Fig. 1.

Never having seen this arrangement of valve, except on paper, we cannot speak to its practical efficiency, but it seems (however ingenious it may be) that the steamtight disc may be a source of trouble and annoyance, if not danger.

We will now proceed to describe Mr. Naylor's arrangement of valves, and show how it obviates the increase of pressure by the rising of the valve, for the escape of steam.

By reference to the accompanying illustration (fig. 2) it will be seen that the valve itself is of the ordinary kind, free in its seat as shown to prevent binding. The lever has one end bent downwards, and the spring for loading the valve is attached to the lower end of the lever, by a loop-link: it will be apparent that as the valve is lifted by the steam from its seat, that is, when the pressure inside the boiler exceeds the weight on the valve, the bent end of the lever moves inwards, or towards the valve, thereby virtually shortening its length, and relieving the weight on the valve, although the tension on the spring is increased by the same movement. This is the principal improvement over the ordinary form of lever, which, as we have seen, increases instead of diminishes the weight on the valve. The amount of relief given to the valve as it opens by this arrangement of lever, may be varied to any extent by the angle given to the lever, and the range of tension on the spring. In the accompanying diagram of the lever (fig. 3), the lift of the valve, the tension on the spring, and the virtual shortening of the lever are shown magnified six times.

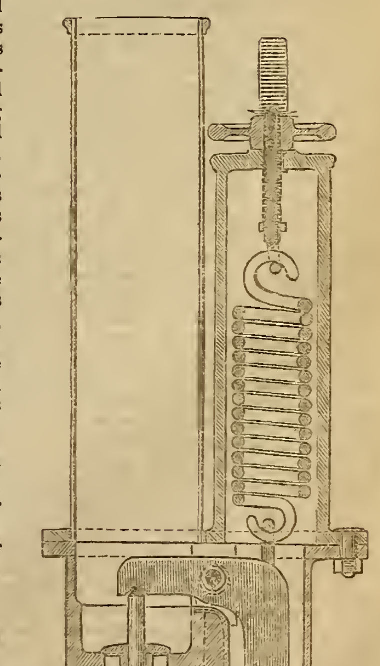


Fig. 2

The thick lines show the dead position of the lever; the dotted lines

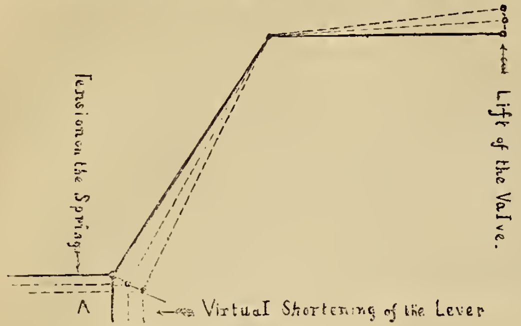


FIG. 3.

show the movement of the lever at its half and full extent of travel The horizontal lines to the right at A, show the amount of tension put on the spring, by the movement of the lever from its dead position, to that of full travel; and the vertical lines at A show the virtual shortening of the lever by the same movement. The tension on the spring is taken at 600lbs. per inch, then, when the bent end of the lever is at an angle of 55° with the horizon, and with a tension of 1,192lbs. on the spring, there will be a pressure of 170lbs. per square inch on the valve; but when by the excessive pressure of steam, the valve has been lifted two degrees, or ·043632 of an inch, the spring has become loaded 36lbs. in excess of the original tension, but to counteract this excess, the bent end of the lever has virtually become shortened ·09 of an inch, reducing its effective action on the valve, whereby the pressure on the valve is reduced from 170 to 168·4lbs. per square inch; this reduction of pressure will be apparent to all of you as a great improvement, opposed to what we saw done by the long lever and spring balance, when the valve is open for the escape of steam. The lift of the valve under consideration is taken at two degrees, the patentee having found by experiment, that with his arrangement this is the average extent of lift for the escape of steam under ordinary circumstances.

Referring to fig. 2, it will be seen that the lever and spring are enclosed in a box, out of reach of the person in charge of the engine or boiler, so that he is unable to overload the valve by holding down or hanging extra weight on the lever, which, as we have seen, is too common an occurrence with the long lever and ordinary mode of weighing; but the person in charge of this valve of Mr. Naylor's can regulate the pressure by the nut wheel, on the top of the spring box, drawing out, or putting tension on the spring until the maximum pressure at which he is allowed to work has been attained, as the shoulder on the screw attached to the head of the spring comes up to the underside of the spring box, rendering it impossible to increase the pressure by that means. Of course the attendant can at any time slacken or ease the pressure down to zero. The amount of pressure on the valve per square inch is shown by the index plate on the side wheel, a pointer being fixed on the head of the screw. Again, looking at the diagram, fig. 2, it will be seen that the friction is reduced to the least possible amount by making all the bearing points of the steelyard, or knife-edged form. A spring, as the mode of weighting, may be objected to from the fact that in consequence of the continual tension on it, in time it will deteriorate and be incorrect in its work. Of course this objection can be raised to Salter's spring balance, as applied with the ordinary lever. Still this deterioration seems to be so slight that the spring holds its place as a mode of weighting safety valve levers. Many of the valves on the locomotive stock of the London and North-Western Railway are directly loaded by such a spring as is employed in this valve of Mr. Naylor's. Granting that the deterioration of the spring amounts to anything, it is at least on the side of safety, relieving instead of increasing the pressure on the boiler.*

With regard to the carrying-off power of this valve the patentee says:—"From experiments made upon different locomotive engines, generating as much steam as they were able, when standing, with a coal fire and steam jet on in the chimney, he found that one of these safety valves, only two inches diameter, carried away the steam, and kept the surplus pressure down 30lbs. to the square inch less than two valves, each four inches diameter, loaded by long levers and spring balances, were capable of doing." On one of the largest locomotive boilers in the country, two safety valves, each four inches diameter, have, we understand, been taken off, and one of Mr. Naylor's, only two inches diameter, substituted. This speaks strongly to the practical efficiency of the valve we have endeavoured to describe.

* Since this paper was written, the patentee has here inserted an india-rubber diaphragm at the bottom of the spring box, to prevent the escaping steam from acting on the spring. This is not shown in our illustration.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

At the ordinary monthly meeting of the executive committee of this Association, held March 27th, William Fairbairn, Esq., C.E., FR.S., LL.D., &c., president, in the chair, Mr. L. E. Fletcher, chief engineer, presented his report, which on that occasion was for two months, since the committee meeting for February had been postponed. Of this report the following is an abstract:—

In the boilers examined 139 defects have been discovered, 10 of those being dangerous, thus.—Furnaces out of shape, 13 (1 dangerous); fractures. 14: blistered plates, 6; internal corrosion 16 (1 dangerous); external corrosion, 9 (2 dangerous); internal grooving, 7; feed apparatus out of order, 5 (1 dangerous); water guages ditto, 11; blow-out apparatus, 18 (1 dangerous); fusible plugs, 6; safety valves, 6; pressure guages, 10; boilers without safety valves (3 dangerous); without feed back-pressure valves, 13; cases of deficiency of water, 2 (1 dangerous). Of the boilers examined 8 have been tested with hydraulic pressure.

Of some of the daugerous defects recorded above details may be given.

The dangerously mis-shapen furnace crowns referred to deserve attention. They were discovered on the first flue examination of a boiler lately enrolled with this Association, and show the importance of periodical inspection. Both furnace crowns were found to be depressed just over the fire, the left-hand one 3ins., and the right-hand one 1⅞in.; while this depression continued to about the midlength of the flue tubes, where it died out. Until this distortion of the furnace crowns was pointed out by our inspector, it was quite unknown to the manager of the works, as well as to the engineman in charge of the boilers. Indeed, our inspector had some difficulty in convincing the latter of the truth of his report, aud only succeeded in doing so on showing him the actual measurements. As soon as the manager was made aware of the condition of the boiler, he gave orders that it should not be worked again until repaired and strengthened, and this is now in hand; but as the furnaces were as much as 3ft. in diameter, and 34ft. long, while they were not strengthened with encircling hoops or in any other way, although made of plates only ⅜in. in thickness, and worked at a pressure of 52lb. per square inch, it is a matter of considerable congratulation that the explosion did not happen before the distortion was detected, and the boiler laid off. And inasmuch as those injured furnace crowns were met with, not at a small factory, at which a common stoker was appointed to the double duty of looking after both boiler and engine, but at a large mill, having a series of four double furnace "Lancashire" boilers, under the charge of an engineer, it shows the importance of periodical inspection even at well-appointed works, aud the assistance that is thereby rendered to those who have the responsibility of management.

Internal Corrosion.—The peculiarity in the case noted as dangerous, under this head, consists in the manner in which the rivet heads were attacked, while the plates at the same time were severely honeycombed, the indentations varying from ¾in. in diameter, and $\frac{1}{16}$in. in depth, to 2in. in diameter, and ¼in. in depth, while the original thickness of the plates was only ⅜in. The rivet heads at the bottom of the boiler were so eaten away and weakened, that a slight blow with a hand chisel only sufficed to brea them off, aud our inspector in this way found he could easily remove them by the dozen, and brought away two or three good handfuls as specimens. It is surely unnecessary to enlarge on the untrustworthiness of seams of rivets attacked by corrosion as these were, while the condition in which this boiler was found to be shows the importance of frequent internal examinations, in order that the effect of the water on the boiler may be watched, and soda promptly introduced with the feed as soon as the slightest tendency to corrosion manifests itself.

External Corrosion.—Two dangerous cases were met with at the bottom of boilers set on midfeathers. The first of these arose from blowing the exhauss steam from the engine into the chimney. A good deal of water, the result of condensation, is carried along with the steam in such cases, and this falling to the bottom of the chimney gets into the flues, and makes them damp, and thus leads to corrosion of the plates as in the present instance. This is by no means a solitary case of a boiler's being injured by this arrangement. The boiler wat corroded on the top of the midfeather, and on each side of it for a width of about 6in., and for a length of about 3ft., and so eaten away as to be reduced to the thickness of a sheet of paper, and our inspector readily knocked a hole through it. The boiler was evidently quite unsafe to be worked on without repair, and therefore the defective plates were at once removed, and are now being renewed. This boiler had been examined early in the year 1863, when warning was given with regard to the midfeather wall. No opportunity, however, since that time, had been afforded the Association of making a flue examination, till the one referred to, a few days since, although this had been constantly requested and the inspectors had regularly visited the works. In consequence of this the guarantee was withheld until an examination could be made. This is clearly justified by the result, which will illustrate the correctness of the course the Association adopts, viz., that of making "internal" and "flue" examinations an essential condition of granting the guarantee.

In the second case the boiler was found to be corroded at nine of the ring seams of rivets, just where they rested on the midfeather, the plates being reduced in places to $\frac{1}{16}$in. This was not discovered until the owner, at the request of the Association, had the midfeather wall ploughed out just where the ring seams of rivets rested upon it. This involves but little expense, since a small opening only is sufficient, and which need not be permanently made up, but can be filled with a little fire clay, so as to be easily removed on the next examination. Attention to this is strongly urged in every case where boilers are set on midfeather walls.

ENTIRE EXAMINATIONS.

The particulars of the defects just given of the furnaces out of shape, of the rivet heads wasted away by internal corrosion, and of the boiler plates nearly eaten through externally, all of which defects could only be ascertained on getting inside the boilers and going up the flues, clearly show the necessity of entire examinations. Notwithstanding, however, the importance which this

Association attaches to this branch of the service, it is one that cau only be carried out by the co-operation of the individnal members. This subject has again and agaiu been called attention to in previous reports, but an earnest appeal is once more made to the members of the Associatiou to have their boilers more suitably prepared for these internal and flue examinations. These are sufficiently trying to inspectors under the most favourable circumstances, but it is clearly impossible for them to make satisfactory examinations when the brickwork is nearly red hot, the flnes choked up with soot, the boilers but partially emptied of water, and the mudhole and manhole covers bolted down.

Four instances in point, which have occurred during the past month, may be given. In the first an iuspector was sent, at a very short notice, and at considerable inconvenience, to a distance involving a four hours' journey by rail, in order to oblige a member who requested an immediate internal and flue examination, as his boiler was standing for a short time while the engine was being repaired, but would be started before the afternoon of the followiug day. On the inspector's arriving at the works at an early hour, as requested, he found the boiler quite unprepared, the flues neither opened nor swept, and on his passing through the furnace into the flue tube, it proved to be choked up with soot to the top of the fire bridge, so that suitable examination was impossible. In the other case the visit of our iuspector was also made by appointment, at the reqnest of the member, but, as before, the flnes had not beeu swept, and our inspector, on getting into them, found the soot 6in. deep. When it is stated that these boilers have for the last six years been worked at a pressnre of from 60lbs. to 65lbs. per square inch, so that the condition of the plates should be very carefully examiued, it will be seen that such preparation for inspection on the part of boiler owners is neither doing justice to themselves, nor to the officers of the Association who are desirons of keeping them safe; and our members must not complain, therefore, if, under such circumstances, the guarantee is withheld. In a third case the sweeps were not sent for to prepare the external flnes till our inspector had begun his examination inside the boiler, althongh he had been assnred on his arrival that all was in readiness. In a fonrth case our inspector on visiting a large mill found the side flues of the boilers to be 6in. deep in soot, and the bottom ones 12in., while the internal flue tnbes were nearly choked np to the top of the bridge, and the plates covered with a cake of soot ½iu. thick. This preparation was anything but satisfactory for boilers 7ft. in diameter, and working at a pressure of 60lbs. per square inch. Snch cases, however, are but too common.

It is trusted that these repeated remonstrances may induce the members to pay that attention to the subject which it deserves, and especial notice was called to it on the approach of Easter, since an extra number of flue examinations would then be made.

Explosions.

Niue explosions have occurred dnring the past two months, by which five persons have been killed aud sixteen others injured, while a tenth, which happened on January 9th last, and resulted in the loss of one life has also to be recorded, since its report did not reach me in time for last table. It will, therefore, now rank as No. 3a. Not one of the boilers in qnestion was under the charge of this Association. The following is a tabular statement:—

Tabular Statement of Explosions, from January 27th, 1866, to March 23rd, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
7	Jan. 29	Plain Cylindrical, egg-ended. Externally-fired	1	5	6
8	Feb. 7	Plain Cyliudrical, egg-ended. Externally-fired	1	3	4
9	Feb. 14	Locomotive	0	1	1
10	Feb. 26	Marine	0	1	1
11	Mar. 3	Ordinary Single-flue, or Cornish. Internally-fired	1	0	1
12	Mar. 5	Plain Cylindrical, egg-ended. Externally-fired	0	5	5
13	Mar. 6	Double-furnace Water-tube. Internally-fired	1	0	1
14	Mar. 13	Double-flue. Externally-fired............	1	1	2
15	Mar. 19	Plain Cylindrical egg-ended. Externally-fired.........	0	0	0
		Total..................	5	16	21

No. 7 Explosion, by which one man was killed and five others iujured, is an illustration of the uusatisfactory and dangerous character of plain cylindrical externally-fired boilers. This subject has frequently been called attention to in previous reports, but is felt to be a duty to continue to do so as frequently as fatal explosions recur from the continued use of this class of boiler.

The explosion in question took place at about a quarter past ten o'clock on the morning of Monday, January 29th, at a colliery, which was uot under the inspection of this Association.

The boiler was about 30ft. long, 6ft. in diameter, and made of plates laid longitudiually, and ⅜in. in thickuess, while the safety valves were loaded to a pressure of a little more than 40lb. on the square inch.

The boiler gave way, in the first iustance, for a length of 5ft., in a longitudinal direction at a seam of rivets over the fire, the reut then developing transverscly on each side of this primary longitudinal one, stripping from the shell an entire belt of au average width of about 6ft., and thus separating the boiler into three pieces, one of which, about 21ft. loug, was thrown to a distance of 210 yards from its original seat.

The cause of this explosion was not shortness of water. The boiler was twenty-five years old, though it had not worked the whole of that time, being idle from 1844 to 1852. It was fed with sedimentary water drawn from the pit, bnt had no sludging or blow-out apparatus, either at the bottom of the boiler, or surface of the water, for removing the deposit. The plates over the fire had suffered and beeu repaired, while the primary reut had occurred in this instance, as it so usnally does, at one of the old plates, and through a seam of rivets uniting it to the new work. There is, therefore, no difficulty in determining the cause of this explosion, aud all boilers working under similar conditions are highly dangerous. In putting new plates into these boilers, the work is frequently so strained that they are weakened instead of beiug strengthened by repairs, and in most cases, at all events, it is impossible to detect this simply by examination, however careful, after the work is completed. This is just one of the reasons that make this class of boiler so dangerous, and which is illustrated by the fact that the boiler in question is reported to have been examined on the Friday and Saturday before the explosion, when it is to be presumed it was passed as safe, or steam would not have been got up in it. On these grounds it is trusted that it will be seen that the recommeudation is not given without good reason, that boilers of tbis treacherous, plaiu cylindrical, exterually-fired construction should be discarded for those fired internally, which are much more reliable.

No. 8 Explosiou, by which one mau lost his life, and three others were injured, occurred to a boiler uot under the inspection of this Associatiou, at half-past five o'clock on the afternoon of Wednesday, February 7th, at a works employed for the mannfacture of angle iron.

The boiler was of plain cylindrical egg-euded construction, 23ft. in length, 5ft. in diameter, and made of plates ⅜in. in thickuess, while the pressure at which the safety valve blew off was about 50lb. on the square inch. The plating of the shell was laid transversely, and consisted of six rings, each 3ft. wide, the longitudinal seams of rivets breakiug joiut, which is the best arrangemeut. The boiler, thongh fired externally, as is usnal in such cases, yet had a peculiarity in the mode in which it was set, inasmuch as it was in commnnication with two furnaces instead of one. The first of these was an ordinary grate furnace fixed underneath the boiler, and set with a flash flue leading direct to the chimney. The second was a mill furnace, the flames passing off from which played first upon one side of the boiler, and theu passed round it by means of a wheel flue. The flash flue from the lower furnace was quite distinct from the wbeel flue belonging to the upper one, and they ouly united in the chimney, so that the boiler could be heated at pleasure by either one of the furnaces separately, or by both combined. The former course it is understood was the one generally adopted, the ordinary fire-grate being only used when the mill furnace was not at work.

The boiler rent longitudiually on one side, at a little below the level of the water liue, and throughout the entire width of two rings of plate. This belt, 6ft. in width, then opened out, tearing through the transyerse seam of rivets at both of its edges, and round the entire circle of one of them, so that the boiler was divided into four. The former of these was thrown out of the works, and across a canal to a distancc, estimated at sixty yards, while the other remaiued on its seat.

There was nothing in the prcssure at which the boiler was worked, nor in its age or condition, to account for thc explosion. The boiler was a new one, and had been at work but a fcw months, and no sigus of deterioration were found on examining the fragments after the explosion. At the longitndinal rent, however, already referred to, there were evident signs of the plates having been overheated, and a consideration of the position of this rent and the attendant circumstances will show how easily this might have happened. This rent was on that side of the boiler ou which the flames from the mill furnace first played, and though they did nct impiuge directly on the plates, since this was prevented by a brickwork shield, yet it was immediately beyond this shield, aud where the flamcs first acted on the plates that the rent occurred. Also the rent took place on a level with the top of the side flues, and thus at a part which would be the first to be laid bare by a deficicucy of water, while as the flues were carried up to within 2ft. of the top of the boiler, there was not much margin for water room, without running a risk of priming. There is, therefore, no reason to doubt that the longitudinal rent, near to the water line, was the primary one, and that it was due to overheating of the plates. How this overheating occurred, however, is not eqnally clear, since the engineman maintains that the water was np to its proper levcl at the time, while he is corroborated in this statement by the foreman of the works, who affirms that he saw him but a minute or so before the explosion occurred, standing on the boiler and working the float wheel, when he observed that the ball rested upon the boiler, and thus indicated high water. To acconnt for this it has been supposed that the float had become disengaged from tbe wire, or that a portion of it had fallen off, so

that the counterbalance ball drew it up and rested on the top of the boiler, irrespective of the water level, and thus gave a false indication. The float, which was blown away by the explosion, has not been found, and it cannot now be proved whether this supposition be correct or not. Plates, however, may become overheated even when a boiler is duly supplied with water. It is extremely trying to a boiler to be heated externally by the flames passing off from a separate furnace, as was the case in the present instance. The action of the flames under such circumstances is so local and intense that the water is, in some cases, driven off from the plates, and it is possible that this may have been the case in the present instance, while it may here be stated that the plates near to the neck of the furnace, where the flames first entered the flue, had been repaired on account of cracks but a month or two after the boiler had been set to work, so that it was evidently distressed from some cause.

Though there is some uncertainty as to the cause of the overheating of this boiler, the explosion is instructive, since it shows the necessity of boilers being equipped with suitable mountings. Had this been the case, this uncertainty could not have arisen. The boiler was fitted with but one float, and a water guage tap, which latter was rendered useless by neglect, since it was choked up. No boiler should be dependent on a single float, and where glass gauges are inadmissabble, and floats adopted, there should be two to each boiler, so that one may act as a check upon the other. Had the boiler been fitted with a low water safety valve, the steam would have been let off on the water's sinking below a desired level, and thus an alarm given, and even if this alarm had been neglected, still the possibility of explosion from a deficiency of water would have been prevented.

In conclusion, this explosion is clearly attributable to overheating of the plates, and while there appears to be some uncertainty as to whether that overheating was due to a deficiency of water or not, that uncertainty would have been removed, and even though deficiency of water had occurred danger would have been averted, if the boiler had been mounted with a suitable complement of fittings.

ON THE PNEUMATIC PROCESS OF REFINING IRON POPULARLY KNOWN AS THE BESSEMER PROCESS.

The following is extracted from a paper recently read upon the above subject, before the American Iron and Steel Association, at Washington, D.C., by Mr. John W. Nystrom, with whose name, as a contributor to engineering science, the readers of The Artizan have long been familiar.

About ten years ago, Mr. Henry Bessemer, advanced a great step, and announced the success of the pneumatic process of refining iron. Since then a great many patents have been procured by Mr. Bessemer and others, both in Europe and America, for improvements in the mechanical arrangement of the converting vessels. The principle of the process—namely, to blow air into molten iron for the purpose of refining the same—is old, and a public property.

In all the different inventions heretofore patented for this purpose, the blast has been applied so as to agitate the molten iron as much as possible, under an impression that the air should penetrate every particle of the mass. In order to accomplish such a great agitation, the tuyeres have uniformly been placed so as to lead the blast into the fluid iron from or near the bottom of the converting vessel. In the cupola-shaped converting vessel the tuyeres have also been placed eccentrically, so as to give the molten iron an agitating rotary motion; but in all cases the most important object, namely, to free the crude iron from its impurities, has not yet been and cannot thus be successfully attained. For while the fluid metal is kept in such a violent agitation, some of its impurities, such as sulphur and phosphorus, which are combined with the iron, have no chance to separate and escape. When the mixed slag and iron is poured from the converting vesssl into a ladle, if sufficiently fluid, the silicia, which is only mechanically mixed with the iron, will ascend and float on the top, and the iron or steel, tapped out from the bottom of the ladle, directly into the moulds, carries many impurities with it, as sulphur and phosphorus.

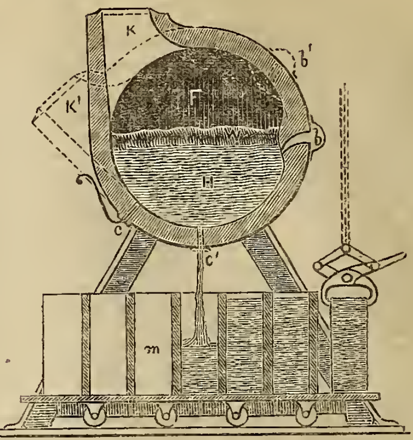
In the Bessemer process the action is so violent, and the indications of the successive grades of refinement so sudden, that it has been found impossible to stop the process at any desired point, from which circumstance the metal is by this method over refined, and actually burned, and then by a subsequent process a composition of manganese and cast iron is added in order to restore the requisite carbon for the steel. The office of the manganese is to remove the sulphur and phosphorus, but as the fluid mass is not kept unagitated long enough while sufficiently hot, that object has not yet been fully accomplished, as will be seen in an analysis of the Bessemer steel, which contains a great deal of these impurities.

The process is so imperfect and so little under control, that it has not yet succeeded in giving a uniform and quite satisfactory result.

The Bessemer process requires a very powerful blowing machine to force the air into the molten cast iron, under a pressure of some twenty pounds to the square inch.

The operation in my pneumatic process of refining iron is entirely different from that of Mr. Bessemer.

Experiments have taught me that in order to accomplish a more thorough refinement of crude iron, it is necessary to keep the fluid metal in the converting vessel *as quiet as possible* during the operation, so as to allow the impurities to ascend to the surface of the metal, which object is accomplished in the following way:



The accompanping figure represents a cross section of my improved pneumatic steel furnace. H represents the molten iron, acted upon by air from tuyeres, *b*, entering immediately under the surface of the iron, where its oxygen combines partly with the carbon, forming carbonite oxide and carbonite acid gas, escaping through the mouth (K), and also combining with the silica and iron, forming a slag (W), of which the upper surface is a flux of silicic oxide, aluminum and lime, and nearest to the iron, a silicate of protoxide and peroxide of iron.

The most important part of the process is now going on between the slag and the crude iron, similar to that in the old refining process where the air is blown on the top of the iron, or, as in the puddling process, where the silicate of oxide of iron is kept in contact with the fluid iron by mechanical manipulation, while heat is supplied from a separate fire.

In the puddling furnaces the heat is not high enough to keep the molten iron sufficiently fluid for a prompt liberation of its impurities. The greater part of the silica which is mechanically mixed with the iron, is subsequently squeezed out by machinery, notwithstanding which there still remains some silica in the iron, just as in wringing out a wet towel, it always remains more or less damp. But much of the sulphur and phosphorus will still remain in the puddled iron, and sometimes greatly impair its quality.

In my pneumatic process a high heat is kept up to boil the fluid iron a sufficient length of time for its required grade of refinement. The sulphur and phosphorus combine with the oxygen in the slag, which oxides are further taken up by the aluminum and lime in the flux, from which surface much is volatilized and passes off through the chimney. A slow circulation is going on in the iron during the process, whereby every particle of it takes its turn towards the tuyeres until refined.

This process requires more time than that of Mr. Bessemer, but the additional time brings it under so much better control, and consequently secures a more satisfactory and uniform result, while the pressure of blast need not be more than about four pounds to the square inch, which can be taken from that of a blast furnace, so that no extra blowing machinery would be required. I have sometimes operated with only one pound pressure.

By changing the blast to suit the condition of the process successively, it is believed that any kind of cast iron can be refined to tolerably good iron, or steel, or, at least, as good, if not better than obtained by puddling. The process can be continued almost any length of time, to suit the kind of iron operated upon. When a new and unknown iron is operated upon by my method, the tuyeres are turned out of the metal and the blast shut off at short intervals, for the purpose of taking out samples with a hand ladle, which are poured into ingots of about ⅜in. square section. Samples are also taken on an iron spit for the purpose of proving the condition of the process.

When the iron is considered sufficiently refined, the furnace is turned so that the mouth (K) occupies the position (K'), and the plug (*c*) the position (*c'*). On account of the centre of gravity of the fluid metal being always perpendicular beneath the axis of the furnace, there is no lifting force required in turning the furnace beyond the overcoming of the friction in the journals, which one man can do with ease.

In the Bessemer furnace, on the contrary, heavy hydraulic machinery, working with a pressure of some 400lbs. to the square inch, is required for operating and lifting the mingled iron and slag and pouring them into a ladle; a proceeding which cannot be adequately carried on without the aid of a steam engine to work the hydraulic machine.

But to return to my furnace. The metal being refined, take out the iron plug, which occupies the position c' and the iron or steel is run out directly into the ingot moulds, as shown in the figure. When each mould is nearly full, the truck is drawn forward until the next mould comes under the jet to receive the metal. When the ingots are sufficiently cold and settled so as to bear handling, the outer part of the mould is lifted aside, and the ingot taken hold of by a pinch hook. My operation requires no heavy hydraulic crane for lifting the refined metal in a separate ladle over the moulds. I do not mix the slag and iron together in or after the process of refinement. My process requires a smaller furnace per weight of metal operated upon, than that used in the Bessemer process. The entire capacity of the Bessemer furnace is about six times, and the weight of the same about four times that of the metal operated upon. The capacity of my furnace is only double, and its weight actually less than that of the iron operated upon.

At a blast furnace my process requires only the converting vessel and ingot moulds, which can be erected at a trifling cost.

The pneumatic steel furnace is now in operation at Nystrom's steel works, Gloucester, N.J., opposite Philadelphia.

THE MANUFACTURE OF WIRE ROPES.

Our Birmingham friends seem to be quite elated at the prospect of opening up the wire-rope making in its neighbourhood. Wire-drawing has been one of their recognised branches of trade, and they appear surprised that this application of it has been the work of others. They have opened their eyes to the few facts which they have accumulated, and pressed them into their argument. The weight, for example, say they, is greatly in favour of wire, as against hemp. A hempen rope of 150 fathoms in length, weighs three-fifths of its working load; while a wire rope, of the same length and strength, weighs only one-third of its working load. To put this in another way. A round hempen rope of 12in. in circumference weighs 33lbs. per fathom; while a wire rope 4⅝in. in circumference, though quite as strong, weighs only 18lbs. per fathom. The test of the breaking strain is equally conclusive; a hempen rope weighing 10½lbs. per fathom, breaks at a strain of 9 tons 5 cwt., while a wire rope, of the same weight, is capable of bearing a strain of 15 tons 6 cwt. before breaking. Then, again, wire ropes are cheaper than those made of hemp, so that every way the advantage rests with the wire. It costs less, weighs less, endures nearly twice the breaking strain, does more work, runs at higher speed with less engine-power, lasts longer, and finally—a great point in collieries—it is much less liable to be affected by damp.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The monthly meeting of this society took place at its rooms in Doctors' Commons, City, on the evening of Saturday, the 7th ult.; Mr. Joseph Newton, President, in the chair. The election of many new candidates for association occupied a considerable portion of the evening, and it was late before the further consideration of the question proposed for discussion, Mr. Oubridge having found an opportunity for re-opening the subject of iron smelting took advantage of it. He commenced by remarking upon the importance of a thorough knowledge of iron smelting both to the founder and the engineer. It was absolutely necessary for the effectual performance of their duties that they should understand the nature of that material with which they were called upon so largely to deal, and also the best mixtures of iron to be used for particular purposes. Unfortunately it happened that many who were in the habit of working iron in its various forms, did not comprehend the fundamental principles regulating, or which should regulate, the various processes employed in obtaining it from the ores. All iron was found in nature in the form of an oxide, and it was the object of the smelter to separate the iron from the oxygen. This was done by simply taking carbon, placing it in a small furnace, setting the carbon free by ignition, common air being added by pressure to increase its volume and so to effect the more complete liberation of the carbon. The oxygen of the air and the carbon when mixed formed carbonic acid gas, and the addition of more carbon created carbonic oxide. When the ore was brought into contact with this in the furnace, its oxide, having a greater affinity for the carbonic oxide than the iron, passed off in the form of gas, and the metal fell to the bottom of the furnace in a highly refined state. When no more carbon was used in this process than was sufficient to convert the iron from its condition of an oxide a ductile metal resulted, not what was commonly called cast iron. It was to this point that Mr. Oubridge particularly wished to direct the attention of his auditors, for although we now made cast iron direct from the ore it was effected by a more complicated process than that he had described. To produce cast iron, furnaces of a very much larger description were required as well as an immense augmentation of the quantity of fuel so as to increase the quantity of carbonic oxide and thus liberate the iron more rapidly. It was essential also to provide a sufficient amount of carbon for the iron to absorb in its downward passage. It was only by having the furnaces high enough to allow a sufficiency of free carbon to exist in the space through which the iron had to pass, that cast iron could be produced. . . . . It was only because wrought iron could not be made in sufficient quantities or so economically by the mode he had mentioned that other means were resorted to, and which allowed of its unlimited production. Thus much as to the making of iron; the next consideration was, how to use it. On a previous occasion he had described the various forms of furnaces in use, but with the best melting furnace in the world it was also essential to possess an intimate acquaintance with the characteristics of the varied qualities of iron. In a scientific, in a practical, and in a commercial sense this held good, although he was aware that very frequently the best iron founders were crippled by restrictious as to the cost of materials. The iron to be used for a column which had to sustain a crushing force would not do for a hydraulic cylinder, wherein great tensile strength was needed. Of course, as a rule, that iron which was freest from such impurities as sulphur or phosphorus was best. Much depended on the quality of the fuel employed in making sound castings, and the best material might be spoilt by using bad fuel. It was important that those who bought iron for foundry uses should be versed in its various peculiarities, for otherwise the foreman might be blamed for defects which should not lay at his door. In the selection of pig iron too much care and judgment could not be exercised. Perhaps the strong red hematite was most free from phosphorus (a mortal enemy to the founder and the engineer, as rendering casting brittle), and, therefore, best adapted for many purposes; but it was desirable to look through the tests of the practical metallurgist, and to study closely the chemical analyses of the different kinds of pig iron. Mr. Keyte enumerated much of his own experience as to the mixture of iron while employed in the Royal Gun Factory at Woolwich, and furnished some excellent practical information for the guidance of the ironfounder. He spoke at considerable length on the subject generally, and before concluding paid a feeling and just tribute to the memory of the late Mr. George Rennie, who had among his other valuable labours, paid great attention to the question of the strength and qualities of cast iron. Messrs. Edmonds, Irvine, Briggs, Ives, Hosken, the Chairman, and Mr. Lawder, followed in the discussion, the last-named gentleman combating some of Mr. Oubridge's statements as to the best form of furnace, and especially disapproving of the drop-bottom system, which Mr. Oubridge had strongly recommended. Mr. Lawder further exhibited a diagram of the kind of furnace he considered best and most economical. At a late hour an adjournment of the discussion, proposed by Mr. Sauson, was carried, and the meeting dissolved.

THE PAST AND PRESENT PRODUCTIVE POWER OF COTTON MACHINERY.

Part I. — *Ancient History.*

Dr. Ure says "The wool-bearing shrub, called Gossypium by botanists, would be universally regarded as a miracle of vegetation, did not familiarity shamefully blunt the moral feelings of mankind. This singular class of plants has been largely distributed all over the torrid zone, a conspicuous gift of Providence to its inhabitants, destined to afford them, in its fleecy pods, a spontaneous and inexhaustible supply of the clothing material best adapted to screen their swarthy bodies from the scorching sunbeams, and to favour the cooling influence of the breeze, as well as cutaneous exhalations. While the tropical heats change the soft wool of the sheep into a harsh, scanty hair, unfit for clothing purposes, they cherish and ripen the vegetable wool, with its slenderer and more porous fibres, admirably suited to Southern, as the grosser and warmer animal fibres are to Northern India. No sooner does the cotton plant arrive at maturity than its swollen capsule bursts, with an elastic force, in three or five gaping segments, in order, as it were, to display to the most careless eye their white fleecy treasure, and to invite the hand of the observer to pluck it from the seeds, and to work it up into a light and beautiful robe. Thus held forth from the extremity of every bough, by its resemblance to sheep's wool, it could not fail to attract the notice of the first tribes which migrated southwards after the primitive dispersion of the human family on the plain of Shinar, and would naturally lead them to employ it for making raiment—an art undoubtedly known to the sons of Noah. Accordingly, the earliest accounts given by historians and travellers of the intertropical nations show them to have been acquainted with the fabrication of cotton cloth. Of all textile materials cotton is the most easy to twist into a fine thread, a process which may be performed upon the plucked filaments with the fingers and thumbs alone. How readily these threads may be converted into a web, the simple weaving machine of the Hindoo sufficiently attests." It would appear that the older Egyptians were unacquainted with cotton, for no traces of its peculiar fibres can be found among the swaddling bands so profusely rolled round the ancient mummies, nor are there any paintings of the cotton shrub upon the tombs of Thebes, where accurate representations of flax occur in its different states of growth and manufacture. Linen was, in fact, the clothing staple of the industrious people, held in such esteem as to be used as a raiment by royalty, and diligently imitated by the neighbouring nations. The Jews first, and afterwards the Greeks and Romans, learned to manufacture linen from the Egyptians. If we consider how near to Syria and Egypt are the regions where the cotton shrub was indigenous,

we may feel surprised that it should have remained so long unknown or neglected by nations to whom it would have furnished a far cheaper and more comfortable article of dress than a flax plant. Indeed the insulation of the cotton manafacture in India, for so many centuries after a considerable intercourse with the East had been established by the conquests of the Greeks and Romans, is one of the most singular phenomena in the history of man, and shows how little inquisitive these highly celebrated people were concerning the arts conducive to personal comfort. Herodotus, who wrote upwards of four centuries before the reign of Augustus, notices distinctly the cotton fabrics of India, and says that a species of plant in that country bears a fruit full of wool superior to that of sheep, with which the natives make cloth for their garments. The general use of cotton as an article of dress indicates that it was no novelty in his time, but that it had been established at a very early date, as we have already suggested. The statement of the father of history is confirmed by Arrian, in the account which he gives of the voyage of Alexander's admiral, Nearchus, who, in sailing down the Indus and along the coasts of Persia to the Tigris, had occasion to observe that the clothing of the Hindoos was a sort of linen made from a stuff which grew upon trees. He calls the cotton shrub tala, and says that the Indians' garments hung down to the middle of their legs, and that they covered their heads with turbans of cotton cloth. On the authority of the same great navigator, Strabo speaks of the printed cotton robes, or calicoes, with much commendation for the variety of their beautiful hues. This writer, who was contemporary with our Saviour, alludes to the cultivation of the cotton shrub and the fabrication of cotton cloth in the Persian province of Susiana. About half a century later, Pliny presents us with a more detailed description of the cotton plant :—"In Upper Egypt, on the side of Arabia, grows the shrub called by some gossypium, and by others xylon, from which cloths called xylina are woven. The plant is small, and produces a fruit like a walnut, which contains a woolly down that may be spun into yarn. This cloth merits a preference over all others for its whiteness and softness, and is made into beautiful robes, which the priests of Egypt delight to wear." Virgil alludes very beautifully to the cotton plant in his second Georgic, where he says, "Shall I sing of the groves of Ethiopia, hoary with soft wool, and how the Seres comb out the delicate fleeces from among the leaves?" Pliny likens the capsule of the cotton plant to the quince-apple in size, and adds that it bursts on being perfectly ripe, and displays its woolly pile, from which a precious kind of linen raiment is made. These wool-bearing trees are called gossympinoi. Hence the Linnæan name, gossypium. The Tylos of Pliny, where these trees were found, is, according to Vincent, an island in the Persian Gulf. Of the Egyptian cotton-shrub, Pliny gives so very explicit a description as to render it surprising that no trace of cotton cloth has been found among the mummy bandages hitherto unrolled in England. Such robes were, perhaps, too valuable to be buried with the dead body, and might be kept as heir-looms from generation to generation. In the downfall of the Roman empire arts and commerce perished. At this dark period there are merely a few incidental notices of the cotton manafacture in the East. Omar, the successor of Mahomet, is described "preaching in a tattered cotton gown, torn in twelve places;" and Ali, his fellow fanatic, who became califf after him, "went on the day of his inauguration to the mosque, dressed in a thin cotton gown, tied round him with a girdle, and a coarse turban on his head." We may hence infer that cotton cloth was a common material of dress in Arabia at the time of the Hegira, and had probably been so for many generations, as the soil was too arid for the production of flax, and the climate too hot for favouring the growth of a soft fleece upon the sheep. The next authentic account of the cotton manufacture of the East is given us by Marco Polo in the thirteenth century. In the vicinity of Mosul, upon the western bank of the Tigris, opposite the ancient Nineveh, "there are places," says this great traveller, "named Mus and Mareddin where cotton is produced in vast abundance, of which they prepare the cloths called boccasini, and many other fabrics." From Mosul, the Italian words mussolo and musselino are derived, whence mousseline and muslin in French and English. Ives states, in his Journey, that "this city's manufacture (or trade) is mussolen, a cotton cloth, which they make very strong, and pretty fine, and sell for the European and other markets." It was therefore a species of calico, so named from the city of Calicut, in the East Indies. In "Menagio's Origini della Lingua Italiana" we find, under the word Mussolo, the following explanation:—"Al Mussoli is a region in Mesopotamia, in which are woven webs of cotton of exceeding beauty, which are called mussoli among the Syrian and Venetian merchants, from the name of this region." Cotton, says Marco Polo, grows abundanty in Persia, and also in Guzerat; in which latter place it is produced from a tree about six yards high, which bears twenty years; but the cotton taken from trees at that age is not adapted for spinning, but only for quilting. Such, on the contrary, as is taken from trees twelve years old, is suitable for muslins, and other manufactures of extraordinary fineness. Of the kingdom of Malabar he says, "Here the finest and most beautiful cottons are manufactured that can be found in any part of the world." Marco Polo was a Venetian, who travelled in the thirteenth century, from the year 1260 downwards, was confidentially employed in China, and returned in 1295 after having visited many countries of Asia. Astley, in his collection of old voyages, says:—"Next day, speaking of a voyage performed in 1608, standing off to sea, they met with a Guzerat ship, laden with cotton, calicoes, and penthathoes (chintzes), bound for Aden." Spain, which had received the cotton manufacture along with its Mahomedan masters, continued for many centuries to cultivate it with much success. The cotton plant still grows wild in many parts of the Peninsula. De Marlès asserts that the Moors, who were mingled with the Arabs at the Spanish conquest, brought with them the husbandry of rice and cotton, as well as that of the mulberry tree and the sugar cane. From the narratives of subsequent Saracenic historians, it would appear that the cotton manufacture was prosecuted to very consederable extent by the Spaniards during the thirteenth, fourteenth, and fifteenth centuries. Barcelona was famous, in particular, for its cotton sailcloth, of which it supplied great quantities to the squadrons stationed off its harbour. The term fustaneros, from which our word fustian comes, which was first given in Spain to the weavers of cotton goods of a stout make, as the Spanish word imports substantial. According to Odoardo Barbosa, of Lisbon, who made a voyage to Southern Africa in 1516, the Caffres then wore cotton dresses, *drappi di bambagio*, denoting a high state of civilisation for that race of people. At Cepala, he says, the Moors grow a large quantity of fine cotton and weave it into cloth, which they use in the white state, from their being unable to dye it on account of the want of colouring stuffs. From "Macpherson's Annals" it appears that cotton cloth, woven on the coast of Guinea, was imported into London from the Bight of Benin, in the year 1590; a fact corroborative of the above testimony.

The state of the New World relative to cotton is very remarkable. When the Mexicans were first invaded by their European conquerors they had no sheep's wool, nor common silk, nor linen, nor hemp, but they supplied the want of wool with cotton, that of silk with feathers, and with the hair of the rabbit or hare. Of cotton they made large webs, and as delicate and fine as those of Holland, which were therefore highly esteemed on their importation into Europe. A few years after the conquest, a sacerdotal habit of the Mexicans was brought to Rome, which Boturini affirms, was uncommonly admired on account of its fineness and beauty. The Mexican men used to wear two or three mantles, and the women three or four vests and as many gowns, putting the longest undermost, so that a part of each of them might be seen. The lords wore in winter waistcoats of cotton, interwoven with soft feathers or the hair of the rabbit. The upper ranks in general used counterpanes of cotton and feathers. We have thus seen that from a very remote period the natives of the tropical countries of Asia, Africa, and America, were well acquainted with the cotton plant, and worked up the woolly down of its pods into useful and ornamental articles of clothing. The Europeans alone continued destitute of this admirable industry for many thousand years after it had been possessed by nations whom, from their less warlike polity, or less ferocious disposition, they looked down upon as inferior races, or regarded even as barbarians. The Portuguese, after the discovery of the passage to India by the Cape of Good Hope, made large importations of cotton stuffs and muslins into Europe, but did not attempt to establish any manufacture of the kind in their own country. When the Dutch, however, some time thereafter, succeeded in depriving the Portuguese of a part of their eastern colonies, they not only extended the traffic in cotton goods, but, towards the latter end of the sixteenth century, began to fabricate them at home. Long prior to this period, a manufacture of indigenous cotton had existed in the southern parts of Italy, where the plant had been cultivated since the eleventh century, particularly along the shores of the Gulf of Taranto. From a remote era, ladies of condition in that district occupied themselves in spinning cotton and knitting the yarn into stockings, articles, of dress which were greatly admired, and fetched the prodigious price of a guinea the pair. The muslin of the same region was likewise in vogue till towards the conclusion of the last century, when it came to be superseded by the large importations from India, and the superior fabrics of England.

The earliest notice of cotton as an article of English trade, is to be found in Hakluyt's Collection of Voyages. It is copied from a little book, entitled "The Process of English Policy." "Genoa," says the author, "resorts to England in her huge ships, called carracks, bringing many commodities, as silk, paper, wool, oil, cotton," &c. This work was printed towards the conclusion of the fifteenth century. Before that period England was probably supplied directly from the Levant with the small quantity of cotton then wanted, chiefly for candlewicks. It appears from Wheeler, who wrote in 1601, that cotton was brought to England by the Antwerpians from Sicily, the Levant, and sometimes from Lisbon, along with many other precious articles, which the Portuguese imported in those times from India. The merchants of Antwerp obtained cotton goods from

Italy before this time, for Guicciardini enumerates fustians and dimities among the valuable articles of import from Milan into the mart of the Netherlands. The people of the low countries soon took up this manufacture themselves, and in the subsequent emigrations of the Protestants from that country, during their religious persecution by the Court of Spain, they brought it into England, and established it in the towns of Bolton and Manchester. The fustians were valued by Guicciardini at 600,000 crowns, but they were probably a mixed stuff. The consequences of the cruelties exercised by the Duke of Alba, are thus powerfully described by M. l'Abbé J. J. de Smet, in his "Histoire de Belge." "The news of the arrival of the Spanish General caused the workshops to be everywhere deserted. Carrying with them their industry, thousands of artizans quitted their country, or enrolled themselves under the insurgent standard. Holland, France, but especially England, offered them an asylum; the provident Elizabeth did not confine her views merely to the relief of her religious partisans, but sought to transfer into her kingdom those prosperous trades of the Low Countries which the adjoining states had looked upon with invidious eyes. She succeeded beyond her most sanguine hopes, and thus eventually procured, with the aid of the Belgian exiles, manufacturing pre-eminence to her country." Lewis Roberts, who published in 1641 a little treatise on trade, called the "Treasure of Traffic," says:—The town of Manchester buys the linen yarn of the Irish in great quantities, and weaving it, returns the same again in linen into Ireland to sell. Neither does her industry rest here, for they buy cotton wool in London that comes from Cyprus and Smyrna, and work the same into fustains, vermillions, and dimities, which they return to London, where they are sold; and from thence not seldom are sent into such foreign parts where the first materials may be more easily had for that manufacture."

(*To be continued.*)

Obituary.

DEATH OF MR. C. WYE WILLIAMS.

We have to announce the death, on the 2nd ult., of Mr. C. Wye Williams, of Liverpool, at the good old age of 87. He commenced his professional life as a barrister on the Northern Circuit. We believe that his first commercial efforts were directed to improving the linen manufacture of Belfast by the application of the Oldham feathering wheel. He next directed his attention to the formation of a line of steam-packets between Liverpool and Ireland. Up to the year 1823 it was considered impracticable to maintain commercial intercourse across the Irish Channel during the winter months. Mr. Williams formed a steam-packet company which was incorporated under the title of "Charles Wye Williams and Co.," and which became "The City of Dubliu Steam Packet Company." He continued the managing director of this company until a few years ago. He also aided the formation of several other companies. All these things gave him but a local position. It was his efforts in relation to combustion, and his pamphlet on "The Combustion of Coal, and the Prevention of Smoke, Chemically and Practically considered," which he produced in 1854, that gave him a wider celebrity. He entered the lists in the competition of makers of economical steam generating boilers at Newcastle for the £500 prize. He was successful, and the judges, Sir William Armstrong, Dr. Richardson, and Mr. Longridge, with reference to Mr. Williams' boiler, pronounced "its extreme simplicity is a great point in its favour." Mr. Williams presented the money prize to one of the popular institutions. In 1856 he received the £25 gold medal of the Society of Arts, which was presented by the late Prince Consort. He was looked on as the father of the steam trade of Liverpool. He was an associate of the Institute of Naval Architects, and of the Institute of Civil Engineers, and esteemed by the members of both these learned bodies.

DEATH OF MR. WHYTEHEAD.

On the 13th of July, 1865, in Paraguay, died William H. Keld Whytehead, Engineer-in-Chief of the Paraguay Republic, in his 39th year. To those to whom Mr. Whytehead was known he was not only an object of esteem for his professional abilities, but he was endeared by his generous and sympathetic spirit and by an amiability of temperament which conciliated a regard that was both wide and enduring. For some years he was the editor and proprietor of this Journal, which he conducted with marked ability, after Mr. Bourne's retirement from it when he first went to India. It was the happy quality of Mr. Whytehead's character to make friends of all who came within the sphere of his intimacy, and the friends he made he retained till the close of his too brief career.

Mr. Whytehead was born at Stepney in 1825. He was descended from an ancient Yorkshire family and while still very young he showed a marked predilection for that profession to which his subsequent life was devoted. He served his apprenticeship with Messrs. Blyth, of Limehouse, with whom he remained seven years, and while still there he first ventured into print in the pages of The Artizan, and achieved a success which in some measure determined his future career. After having conducted The Artizan for some time he abandoned its active management to take charge of the engine works of Messrs. Nillus, at Havre, and in 1854, he was introduced by Messrs. Blyth to General Lopez, President of the Republic of Paraguay, as an engineer eminently fitted by his talents and integrity for carrying out the various important engineering works contemplated by that Government. He left England with General Lopez, in November, 1854, to fill the office of chief engineer to the Government, in which office he continued up to the time of his decease.

It is needless to say that the duties which Mr. Whytehead was called upon to perform upon his arrival in Paraguay were of a very arduous character, and well and faithfully did he perform them. Not only had he to create an arsenal and workshops, but he had to train the men to the knowledge of how to use the tools which were now for the first time put in their hands, and he had to create order and subordination out of a concourse of unruly atoms. In 1860 he visited England when he procured a supply of the best tools and apparatus suited to his purposes and and the arsenal he created at Asuncion, and which has no equal in South America, constitutes a splendid monument to his memory. The Buenos Ayres *Standard* thus testifies to this achievement:—"How well he accomplished so difficult a task with the rude elements at his disposal is known to those who have visited the magnificent establishment of Asuncion, with which his name will ever be associated."

But it was not in the creation and supervision of this establishment alone that his labours consisted. All the engineering work of the Government, excepting only the conduct of the railway, devolved upon him, and these heavy labours were seriously aggravated when war broke out between Paraguay and Brazil. Then, the climate is unfavourable to great exertion and is trying to most English constitutions. In 1863 he was seized with dysentery, and while still weak from this complaint, he and his foreman were stabbed by a drunken workman in the arsenal—not fatally, but so seriously as still further to enfeeble him and to shake his nervous system. The workman was shot notwithstanding Mr. Whytehead's intercession in his behalf, and this event contributed further to depress him. He was warned by Dr. Stewart that he was doing too much in his enfeebled state and that he ought to return to England, and the President and chief residents manifested the deepest interest in his recovery and welfare. But in the critical position of the country he was unwilling to leave his post, feeling how ill he could be spared, and he offered up his life at what he believed to be the shrine of duty. On the morning of the 13th of last July he was found dead in his bed, worn out by excessive brain work acting on an enfeebled frame.

The world holds on its course. But old faces disappear and new ones rise up to fill their place. One by one "from love's shining circle the gems drop away," and often the gems prized most highly disappear first. By Mr. Whytehead's death the engineering profession has lost a talented, devoted, and sterling member, and many have lost a genial, trusted, and beloved friend.

DEATH OF GEORGE RENNIE, Esq., C.E., F.R.S.

George Rennie was born on the 3rd of December, 1791, in Surrey, and died on the 30th of March (Good Friday), 1866, in the 75th year of his age, at his house, 39, Wilton Crescent, London.

Mr. Rennie was the eldest son of John Rennie, well known from his numerous engineering works. From early life George Rennie was brought up under his father as an engineer, for which profession he showed the greatest talents. His general education was commenced at the establishment of the late Dr. Greenlaw, at Isleworth; from thence he was sent to St. Paul's School, under the well known Dr. Roberts. In 1807, he accompanied his father in his annual professional tour through Great Britain and Ireland, and was present at laying the foundation stone of the celebrated Bell Rock Lighthouse, which was to be constructed under his father's direction. He was then placed at the University of Edinburgh, under the charge of the Rev. Dr. Robertson, Professor Playfair, the well known natural philosopher, the other professors in the University at the time being Leslie, Hope, Christison, and Dunbar, he left Edinburgh in 1811, and returned to London and commenced the study of mechanical and civil engineering under his father. His first attempt was the construction of a model of a steam engine for which the tools were selected for him by Mr. Watt, senr. From this time he assisted his father in designing many of his great works, such as Waterloo and Southwark bridges, Lincolnshire drainage works, the improvements of Plymouth, Portsmouth, Pembroke, and Chatham dockyards, and Plymouth, Kingstown and Holyhead breakwaters and harbours, &c.

In 1818, Mr. Rennie was recommended by Sir Joseph Banks and James

Watt for the post of Inspector of Machinery and Clerk of the Irons or Dies at the Royal Mint, then recently erected on Tower Hill, in which situation he continued eight years and acquired an intimate acquaintanceship with the processes of coining; this knowledge was afterwards turned to good account in the construction of the Mints of Calcutta and Bombay which he undertook in conjunction with Messrs. Bolton and Watt as well as the coining machinery at Paris, Mexico, Peru, and Portugal. The great steam forge at Woolwich owed much of its perfection of detail to his ability. In 1821, his father, John Rennie, died, and George Rennie, with his brother (the present Sir John Rennie), proceeded to carry on the mechanical and civil engineering works of their father, amongst other works, London Bridge was erected after the design made by George Rennie and approved of by his father, but Sir John Rennie was appointed engineer to carry the works into execution in consequence of the government appointment George Rennie then held. One of the most important works that the two Rennies were called upon to complete was the dockyard of Sheerness; this was commenced after a plan made in 1813 by their father and a more extended plan in 1821, at a total cost for the engineering works for the dockyards of about two and a half millions sterling. This was by far the most complete and systematic dockyard at that time in the kingdom. A splendid model of these works may be seen at the South Kensington Museum. The cast iron dockyard gates were then a novelty and have stood well to this day, the heel post being accurately ground into the masonry to insure a tight joint, the success of those gates led to the construction, under Mr. Rennies's direction, of the ten pairs of large dock gates at Sebastopol, which are amply described in a paper read at the Institution of Civil Engineer's.

In the Rennie's mechanical works in Holland-street, Blackfriars, very important works were constructed both of a novel and difficult character, and at a time when the numerous appliances of tools and other arrangements for facilitating works in iron at present in use were then unknown. In the construction of the shields for the Thames Tunnel, one of the earliest, if not the first, machine on a large scale for planing iron was then used for the purpose of fitting together the different parts of the shields, and which machine we understand is still to be seen in Messrs. Rennie's factory. Another important work under the direction of Mr. Rennie, was the biscuit machinery at Weevil, near Gosport; this was the first machinery constructed on any system for making biscuits; the idea of making biscuits for the Government by machinery is due to the late Sir Thomas Grant, but whose crude ideas were brought into practical effect by Mr. Rennie and his able assistant Mr. Gideon Scott. The corn and chocolate mills of Deptford Royal Victualling Yard, as well as the more magnificent establishment, called the Royal William Victualling Yard, at Cremil Point, near Plymouth, were also due to the skill of Mr. Rennie; the latter were completed about 1835.

In the introduction of railways, Mr. Rennie played a very important part, for after the bill for the Manchester and Liverpool Railway had been thrown out, the line originally proposed by Stephenson being very circuitous to avoid the Chat Moss besides other defects, Mr. Rennie was called in to propose a new line, the survey of which was made under his direction and which line Mr. Rennie carried through Parliament in 1826. This line was afterwards carried into execution. One of its most remarkable features was making the railway right over the Chat Moss, after Mr. Rennie had satisfied himself there would be no practical difficulty in doing this the next operation was to make the survey across the Moss, this was effected during a severe frost. Mr. Rennie then determined to take it over the widest and highest part of the Moss, being a distance of four miles, he also estimated this part of the line not to cost more than £30,000 and the actual cost was only £27,719. This difference may in part be accounted for by the difference in the guage finally adopted, viz., 4ft. 8½in. instead of 5ft.; it is probable if this original guage of 5ft. had been adopted there would not have been the great battle of the guages which resulted in a broad and narrow guage being used on different railways at a useless expense. The total estimate for the railway submitted to the committee by Mr. Rennie was £796,246. The railway actually cost £739,165. It was, perhaps, the most unfortunate part of Mr. Rennie's professional career that these works principally designed by him were not carried out under his directions. In 1826, the late well known architect, Mr. Harrison, of Chester, proposed a stone bridge over the River Dee, with one span of 200ft. Mr. Harrison being too old and infirm to carry it into effect, the Corporation of Chester consulted Mr. Rennie as to its practicability. The design was placed in his hands, which he investigated thoroughly, equilibriated the arch and proposed to carry the abutments down to the solid rock; a very ingenious centre for supporting the arch while building was also designed; indeed the design was so far remodelled as to become a practical reality; from want of funds the execution was delayed for a time, but eventually carried into execution on this design by Mr. Jesse Hartley and Mr. Trubshaw. In 1836 and 1837, Mr. Rennie, in conjunction with Messrs. Chapman and Jessop laid out a line between Birmingham and Liverpool to cross the Mersey at Runcorn, with a magnificent viaduct; this was to have been in connection with a line laid out by his brother, Sir John Rennie, between London and Birmingham, and, if carried out, would have reduced the distance to a minimum. Mr. Rennie also laid out and commenced the grand junction line to connect the east and west parts of London, and other lines. In Belgium he executed the Namur and Liége and the Mons and Manage Railways. The former has three elegant stone bridges, the largest of which crosses the Meuse at Val St. Lambert, and consists of five arches of 80ft. span. The form of the arch is segmental, and spandrils are ornamented with handsome wreaths sculptured on the stone. Amongst other successful works may be mentioned that of the Staines Bridge, consisting of three stone arches.

He was elected a fellow of the Royal Society in 1822, and was afterwards selected to fill the place of Treasurer, vacated by Sir John Lubbock, this situation be occupied until 1850. Having naturally a philosophical turn of mind he devoted his spare time to making experiments and communicating them to the scientific societies. In 1825 and 1826 he made a vast number of experiments on the friction of metals and other sub, stances, and papers on the friction of fluids, solids, and strength of metals which were communicated to the Royal Society in 1828. These experiments still hold their place for their accuracy and practical value, and at that time may be said to have been quite a new idea, for it was three years previous to those made by General Morin, who, assisted by the French Government, pursued the subject further. Mr. Rennie was afterwards appointed one of the Royal Commissioners for investigating the strength of iron, and was assisted by Mr. Hodgkinson. In 1834 he wrote a valuable paper for the British Association on the "History, Principle, and Practice of Hydrostatics, Hydraulics, and Hydrodynamics; in 1857, a paper on the employment of bêton or concrete in works of engineering and architecture. About the year 1836, Mr. Rennie took much interest in the subject of propelling vessels by the screw propeller. That propeller in various forms, as is well known, had been tried by Painton in 1768, Littleton in 1794, Shorter in 1802, and then Napier, Tredgold, and Brown about 1825, Dugent about 1827. Mr. Pettit Smith tried a small boat in 1836. It was this last experiment principally that interested Mr. Rennie, and so strongly convinced was he of its utility, notwithstanding the unfavourable opinions expressed by some of the best mechanical engineers of the day, that he and his brother determined to join in the construction of a vessel (both at great pecuniary as well as professional risk) to be propelled by the screw propeller driven by engines of 80 horse-power, fitted in the *Archimedes*, built especially for the purpose. She succeeded so well that a speed of nine miles per hour was obtained; thus establishing the principle which has since been so extensively adopted.

In 1840, Mr. Rennie, in conjunction with his brother, proposed to the Admiralty the fitting of a small vessel called the *Mermaid*, of 210 tons. This vessel, when completed and tried, obtained a speed of twelve and quarter miles per hour, being four miles in excess of the paddle-wheel steamers then in use, in H.M. navy. In 1852, he took up the subject of double or twin screw propellers (which had previously been proposed by a Capt. Carpenter), and made a small boat in the River Thames to experiment upon. This system has been since extensively adopted by the Messrs. Rennie, in light draft gunboats, and is now much in favour for war purposes. Mr. Rennie was consulted in connection with many harbours, bridges, waterworks, &c., and in the old-established engine works with which he was connected constructed marine and land engines; and musket machinery at Constantinople. Amongst the breweries erected by him is the complete and extensive one at Louvain, in Belgium; and many civil and mechanical works of different kinds, it would not be possible to enumerate them all in this limited account of his long professional career.

It will be recollected that, some little time back, Mr. Rennie met with a severe accident, when crossing from the works in Holland-street, and from which he never recovered.

When we look back but for a short period, and count the number of those amongst the scientific and other celebrities of our own time who have departed this life, we do not find one amongst them who possessed the regard and esteem of all who knew him so eminently as the late George Rennie, and amongst so large a proportion of men of all ranks and in all stations of life; indeed, to have known him long in professional intercourse, alone involved the certainty of those kindly feelings which produce lasting friendships; and to have the advantage of a closer intimacy with him secured unfeigned pleasure, and that highest esteem and regard which a man combining great personal worth, urbanity, simplicity of manner, and scientific attainments can alone secure. Such, indeed, was George Rennie, of whose useful and eventful life we have upon the present occasion been able to give but a brief and imperfect sketch, not only on account of the lack of materials for such purpose in our possession, but also from the comparatively small space within which we are compelled to confine ourselves in our monthly issue.

George Rennie was buried on April 5th, 1866, in the churchyard of the quiet country church of Holmwood Common, near Dorking, Surrey. The funeral being quite private. He leaves a wife and three children; his two sons carry on the business of engineers on the same premises which are now occupied by the third generation of engineers of that family.

REVIEWS AND NOTICES OF NEW BOOKS.

Geology. By M. A. Purcell, C.E. London: Stanford, Charing-cross.

An ingenious geological table has just been published by Mr. Matthew A. Purcell, which contains the complete histories, classes, and ingredients of the fossiliferous matter which composes the structure of the earth's crust.

The subject has a general interest, and we cordially recommend this table to the attention of the scientific student.

As a specimen of its lucidity and comprehensiveness, we quote the properties and history of coal.

We find this mineral described thus. Its class is *Primary* or *Palæozoic*; its system *Carboniferous* in the upper formation of three. Under the heading of its *Life Characteristics in different periods* we have *Asterophyllites, Calamites, Lepidodendron, Sligmariæ, Sigillariæ, Ferns,* &c. It is of both marine and fresh water origin. Under the final head of *Observations* we have this admirable consummation, *Shale, Sandstone, Grit, and Seams of Coal* (*coal being decomposed vegetable matter*). Further comment upon it we need not make. The brevity of the above, which contains volumes of information, is eloquent enough. We may remark that it is dedicated to Robert Harkness, Esq., F.R.S.L. and E., F.G.S., Professor of Mineralogy and Geology, Queen's University in Ireland.

The author of this table has received numerous testimonials from Sir Robert Kane, F.R.S., &c., of the Department of Science and Art, Museum of Irish Industry, Dublin, and other men of science.

A Treatise on the Screw Propeller. By John Bourne, C.E. London: Longmans, Paternoster-row. 1866.

We have received Part VII., which continues the historical account of the Screw Propeller up to the period of Mr. Richard Roberts' patent of 1852. The tables of performance of screw steam vessels in her Majesty's navy, published in 1865, are also continued up to the *Shannon*. The part is accompanied by two plates—one illustrating, by a plan view and longitudinal sectional elevation, the screw steamer *Surat*, 500 h.p.; and the other illustrative of Mangin's screw as fitted to her Majesty's screw steamer *Favourite*.

Adcock's Engineer's Pocket-book for 1866. London: Simpkin, Marshall, and Co., Stationers' Hall-court.

Although this old established annual—indeed we believe the oldest of the Engineers' Pocket-books—made its appearance on the present occasion considerably later than usual amongst us, it is not the less welcome as an old acquaintance; for we should have been sorry to see realised what it was feared by its friends had been its fate "to be numbered amongst the things that have been, but are not." On looking through its pages we observe several novelties, and the entire contents exhibit care and attention in their selection and arrangement. A selection of extracts of papers read at the Institution of Mechanical Engineers is given, and several notices of useful inventions and other matters of interest which we have not seen noticed in any other similar publication, are contained in Adcock's Engineers' Pocket-book for 1866. Altogether, the edition for the present year is not only not inferior to any preceding issue, but will be found to contain matters of greater interest.

Supplement to the Treatise on the Turbine, or Horizontal Water Wheel. with two Plates, specially designed for the use of Operative Mechanics. By William Cullen, Millwright and Engineer. London: E. and F. N. Spon, 16, Bucklersbury. 1866.

When Mr. Cullen published his Treatise on the Turbine, or Horizontal Water Wheel, we noticed at considerable length the result of his laborious and interesting researches, and we have from time to time, whenever we have been asked to recommend a *practical* treatise on that important subject, recommended the study of Mr. Cullen's work; the occasions on which we have been thus applied to have been numerous and from all parts of the world; and we must here do Mr. Cullen the justice to state that from several of our correspondents we have received confirmatory evidence of the sound practical character of Mr. Cullen's work when tested by the practical experience of those who have adopted it for their guide in constructing and employing turbines. In the present instance we are unable to do but little more than notice the publication of the supplement, which is devoted to the practical consideration of vertical water wheels, their proper construction, and the selection of the kind or description best adapted to the intended purpose; and to add that, judging by the arrangement of the subject Mr. Cullen has made, and the treatment of each division, the present supplemental work (which is of uniform size with his Treatise on Turbines) will be found as valuable, as a work of reference and practical authority, as his previous treatise.

Mr. Cullen has prefaced the consideration of vertical water wheels and their construction, with some useful observations and calculations concerning the measurement of the flow and discharge of water under various conditions—in rivers, on overfalls and weirs, through sluices, &c. On the subject of vertical water wheels he has given their proportions and the best forms of their parts, in relation to the quantity of water and the work to be done—of breast wheels, their velocity, and the shape of the buckets—on the relative advantages of breast and overshot wheels, the capacity of buckets and depth of shroudings—the depths of shroudings and horse power relatively—of overshot wheels with quick speed, and rules for proportioning them, with examples thereof.

There are numerous diagrams illustrating the formation of buckets for undershot, breast, and overshot wheels, &c. Besides the foregoing there are numerous tables, such as, of the diameters of spur wheels, &c., with explanations and examples of same, and also a useful little table by which to find the strength of cast iron teeth of wheels for any given velocity, and textual illustrations and examples for practical use.

Having said thus much about the contents of Mr. Cullen's supplement, we fear our readers will expect to find the work a volume of some two hundred pages and more. In this, however, they will be agreeably disappointed, for the whole is comprised in some fifteen pages of letterpress and two plates, and Messrs. Spon have published it at a price within the means of every practical mechanic.

NOTICES TO CORRESONDENTS.

Our Cornish Correspondent M. is correct, for there are two "cigar boats," one of them, the *Walter S. Winans* was built by M. Nillus at Havre. She is only 72ft. long and 9ft. in diameter, propelled by a high pressure 25 horse-power engine. The other boat was built at Blackwall, and named the *Ross Winans*, which we have noticed in the present and previous numbers of The Artizan.

There can be no necessity for the explanatory calculations of our corresdent X. now that the *Northumberland* is fairly launched. Our impression is, that Mr. Longley is a shipwright, and that Sir John Hay is a sailor. We are obliged, and shall be the more so, whenever his favours are repeated.

We shall be glad to hear again from C.M. of Merthyr. Our iron manufacture has seen many changes, and some improvements, of late years. His promised paper shall command our best attention.

A. D. F. R. is respectfully declined.

The Sugar Question.—We perceive that the Society of Arts has entertained this question, at one of its meetings. It was presented to the members from the engineering point of view, without novelty. Even the recent improvements in engines and in mills, do not appear, by the Journal of the Society, to have been appreciated in the paper which was read on the occasion. It remains for the chemistry of the question to be properly handled, and then for some gentleman of experience, in these things, to unite and apply them.

The New Atlantic Telegraph.—The preparations on board the *Great Eastern* for receiving the new Atlantic telegraph have at last been completed, and the important work of stowing away the cable in the tanks prepared for its reception has commenced. The *Iris*—the hulk which was lent by the Government to the Telegraphic Construction and Maintenance Company, Limited, for the purpose of bringing down the cable from the works at Mordan Wharf, East Greenwich—arrived alongside the *Great Eastern* with upwards of 200 miles of the new telegraph on board, and the work of winding it on board will continue without intermission till the whole is stowed away. At the end of June or the beginning of July, according to present arrangements, the *Great Eastern* will again commence her hazardous enterprise of laying the cable, which every one connected with the work is sanguine will this time be accomplished. The ship has behaved herself exceedingly well during her winter residence in Sheerness Harbour, and notwithstanding that her immense broadside has been exposed to some of the heaviest gales ever known, it has never been necessary on any occasion to get up steam, as her anchorage has been quite sufficient for her security.

PRICES CURRENT OF THE LONDON METAL MARKET.

	March 31.			April 7.			April 14.			April 21.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	94	0	0	94	0	0	94	0	0	94	0	0
Tongh cake, do.	91	0	0	91	0	0	91	0	0	91	0	0
Copper wire, per lb.	0	1	0	0	1	0	0	1	0	0	1	0
„ tubes, do.	0	1	$0\frac{3}{4}$	0	1	$0\frac{3}{4}$	0	1	$0\frac{3}{4}$	0	1	$0\frac{3}{4}$
Sheathing, per ton	96	0	0	96	0	0	96	0	0	96	0	0
Bottoms, do.	101	0	0	101	0	0	101	0	0	101	0	0
IRON.												
Bars, Welsh, in London, per ton	7	10	0	7	10	0	7	10	0	7	10	0
Nail rods, do.	8	7	6	8	7	6	8	7	6	8	7	6
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	7	6	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	3	16	0	3	16	0	3	18	3	3	18	0
LEAD.												
English pig, ord. soft, per ton	21	0	0	21	5	0	21	0	0	21	0	0
„ sheet, do.	21	10	0	21	10	0	21	15	0	21	15	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	20	2	6	20	2	6	20	5	0	20	5	0
BRASS.												
Sheets, per lb.	0	0	$10\frac{3}{4}$	0	0	$10\frac{3}{4}$	0	0	$10\frac{3}{4}$	0	0	$10\frac{3}{4}$
Wire, do.	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$
Tnbes, do.	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$	0	0	$11\frac{1}{2}$
FOREIGN STEEL.												
Swedisb, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	8	0	0	8	0	0	8	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per hox	1	15	0	1	15	0	1	15	0	1	15	0
IX „ „ „	2	1	0	2	1	0	2	1	0	2	1	0
IC „ 2nd qna., „	1	13	0	1	13	0	1	13	0	1	13	0
IC Coke, per hox	1	8	0	1	8	0	1	8	0	1	8	0
IX „ „	1	14	0	1	14	0	1	14	0	1	14	0

RECENT LEGAL DECISIONS.

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the mannfacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possihle, to divest our remarks of all legal technicalities, and to present the snbstance of those decisions to our readers in a plain, familiar, and intelligihle shape.

PARTNERSHIPS.—It has been decided by Vice-Chancellor Kindersley, in the case of Wilkinson *v.* Eykyn, that partnership property cannot, as against the partners, be pledged as a security for the private debts of a member of the firm.

VENDOR AND PURCHASER.—In the case of Tate *v.* Williamson, a bill had been filed by the representative of a vendor, deceased, to set aside a sale of real estate on the following grounds: First, that the purchaser stood in a fiduciary position towards the vendor at the time of the sale: secondly, that the purchaser took advantage of the youth and inexperience of the vendor, and concealed from him important information as to the value of the estate; thirdly, that the price given was inadequate. Vice-Chancellor Wood made a decree setting aside the sale, and holding that where confidence exists hetween two parties of such a nature as enables the person trusted to exercise influence over the other confiding in him, no transaction between them ean be sustained unless there has been the fullest communication on the part of the person trusted of every particular known to him relating to the subject matter of the contract.

EXECUTORS' LIABILITY.—In the case of Davenport *v.* Moss, before Vice-Chancellor Wood, where an executor, out of moneys paid to him by his co-executors for the purpose of being paid into the Court of Chancery, retained a debt due to himself as against a receiver appointed by the Court, and refused to refund it, his co-executors were held personally liahle to the receiver for the money so retained.

INTEREST ON PURCHASE MONEY.—The Lords Justices have affirmed the decision of the Master of the Rolls, in the case of Williams *v.* Glenton, holding that where a purchaser has agreed that if, from any cause whatever, the purchase shall not he completed hy a day named, he shall pay interest on his purchase-money, the mere existence of a difficulty as to title, though caused by the *laches* of the vendor, not being sufficient to absolve the purchaser from his inability to pay interest. In such a case nothing short of misconduct on the part of the vendor will discntitle him to maintain a claim for interest.

DEPOSITS ON SHARES.—A statement in the prospectus of a joint-stock company, "Deposits returned if no allotment made," does not create a trust in favour of subcrihers for shares who have paid deposits to the account of the company, as against creditors of the company who seek to attach the moneys standing to the company's banking account, although the company proves abortive and no allotment is ever made. This was the holding of Vice-Chancellor Wood, in the case of Moseley *v.* Cressey's Company, where a bill had heen filed against the company by certain persons who had paid deposits on their applications for shares. The Vice-Chancellor said, the money when paid, as deposits, hecame part of the company's assets; and there were other persons to be considered besides the depositors, namely, creditors who had supplied goods to the company when registered, trusting to its assets for payment. If they had understood that there was no balance at the baukers they would not have supplied the compauy at all. Faith was to be kept with them as well as with the persons who helped to get up companies in this singular way, in the hopes of profits, but which generally ended in ruin.

ATHERTON *v.* MANGAN (Court of Exchequer, Sittings in Banco).—This was an appeal from the County Court of Staffordshire. The action was for negligence in having a dangerous machine in a public place, whereby the plaintiff injured. The defendant had placed a crnshing machine in the market-place of Lichfield on a market-day without anyone in charge. Some boys hegan meddling with the machine and set it working, and the plaintiff, a child three years old, was indnced to put his hand iuto it, and was thus seriously injured. The jury acting upon the judge's ruling found a verdict for the plaintiff. The gronnd of the appeal was that the plaintiff's own fault caused or contrihuted to the accident, for that his being a mere child made no difference in the matter. Judgment for the appellant.

CONROY *v.* SKINNER.—This was an action by the plaintiff, who had been in partnership with the defendant in a patent steering apparatus, for board and lodging from the 5th of December, 1864, to the 12th of September, 1865. The defence was in substance that there was never any contract, that the plaintiff had never made his claim uutil the defendant had sued him for money lent, and that at the dissolution of the partnership a discharge of all claims was given by the plaintiff to the defendant. After a long trial, a very careful summing up by the judge, Baron Channel, and some deliberation on the part of the jury, a verdict was fouud for the defendant.

PENN *v.* JACK, *v.* BIBBY, AND *v.* FERNIE.—These were suits instituted hy Mr. John Penn, of Greenwich, in Vice-Chancellor Wood's Court, to restrain the defendants from infringing the plaintiff's patent of October 2nd, 1854, for improvements in the hearings of screw propellers. The object of Mr. Penn's invention was to provide efficient and durable hearings capable of sustaining the weight and resisting the enormous wear and tear caused hy the revolution of the shafts of screw propellers. This is effected by fixing in the collar, or bearing of the propeller, fillets or strips of wood in such a manner that the propeller shaft turns upon the wooden fillets, between which water is allowed freely to flow, thereby preventing the metal from turning upon metal, and providing efficient lubrication hy means of the water. When propellers were first introduced about 1840, very great difficulty was fouud in providing suitable bearings; when they were made of metal, the friction caused them to heat, and the wear was so serious as sometimes to endanger the safety of a ship, and in all cases to cause serious loss. These inconveniences were so great, that for some time, it was doubtful whether propellers of great size and weight, could be used with advantage. An efficient remedy was, however, supplied in 1854, when Mr. John Penn, after making experiments, hit upon the simple remedy of using wood for his hearings. With metal, the bearings of screw steamers used to require repairs after short runs of hundreds of miles, hut with Mr. Penn's bearings, vessels driven by large and heavy screw propellers, run scores of thousands of miles without the propeller hearings showing any signs of wear. Immediately upon the introduction of the invention of Mr. Penu, its success was recognised, and it was adopted in the Royal Navy, and in many steam vessels of trading companies and private firms. The defendants disputed the validity of the patent on the several grounds that the iuvention was not new, and was not the proper subject of a patent, and that the specification was insufficient. The case was not concluded at the time of our going to press.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possihle, more especially with a view of benefiting those of our engineering hrethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harhours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

A NOVELTY.—Mr. Binney, F.R.S., recently exhibited at the Manchester Literary and Scientific Society a singular mineral, which Mr. Ward, of Longton, had found in a nodule of clay ironstone from the North Staffordshire coal-field. On careful examination it appears to be a mineral mass in a semi-crystalline state. The form of the mineral appears to have been spheroidal, with crystals radiating from the centre. It consists chiefly of carbonate of lime, carbonate of iron, and phosphate of lime, with traces of magnesia, alumina, and organic matter, and 10 per cent. of silica. He also exhibited a beautiful white specimen of carbonate of strontia, obtained from a vein of carbonate of lime. It occurred among the lime in radiated masses, similar to those of carbonate of barytes, as sometimes found in veins of sulphate of barytes. This mineral has heen obtained in considerable ahundance, hut up to this time it is believed that no use has been found for it on a large scale.

INTENSE HEAT BY THE COMMON COAL GAS.—M. Schlœsing discovered an arrangement by which he melts iron with ordinary gas. He secures complete combustion of the proportionate amounts of gas and air within a confined space, securing a continuous supply of the combustible materials. His chief apparatus is a copper tube, carefully pierced.

WATER-METERS.—A premium has been offered by the Industrial Society of Amiens, in the following terms:—The proprietors of steam-engines are in want of a water-meter which will indicate exactly the quantity of water injected into the boiler, whatever be the pressure. This apparatus must be one easily set up, not subject to get out of order, and capable of registering the quantity of water to within two per cent. of the actual volume. It is not a memoire that the society wishes for, but an apparatus in working order on which experiments can be made; and if a water-meter be presented appearing to be of practical utility, the society will use every effort in its power to promulgate the use of the contrivance. The meters to be experimented on should be sent to the office of the society before March 1st, 1867.

CLEANING SILVER OR SILVER-PLATE.—Dr. C. Calvert, F.R.S., suggested, in the recent

Cantor lecture, the following simple process. Plunge the silver article, for half-an-hour into a solution made of 1 gallon of water, 1lb. of hyposulphite of soda, 8oz. of muriate of ammonia, 4oz. liquid ammonia, and 4oz. cyanide of potassium. The latter may be dispensed with, if necessary. The silver article being taken out of the solution, is washed in clean water, and then rubbed over with wash-leather.

Steam Fuel.—We understand that Mr. C. T. Richardson has been steadily prosecuting experiments at Woolwich Dockyard, to determine the value of petroleum as a steam fuel. The great difficulty hitherto has been to reduce the amount of dense smoke and soot which has been given off during the combustion of petroleum, and which is simply a proof of the want of oxygen in the combustion chamber. We hear that one or more jets of steam will be tried to promote the desired perfect combustion of the gases of petroleum.

Ship Plates and Boiler Plates for the Government.—We hear that Messrs. Shaw and Thomson, of Leadenhall-street, have taken the contract for these plates, for the Stockton Malleable Iron-works, Stockton-on-Tees. The Messrs. Moser and Son, of the Boro', signed the contract, which it is expected will be £100,000 for the year.

Slates.—The test of a superior slate is its ability to remain unbroken, after being made red-hot in a furnace, and suddenly immersed in cold water, whilst at that heat.

Gold has been discovered in the Island of Sitkha, when digging holes to receive the poles of the American telegraph. The geologic formation there, appears to correspond with that of California, which adds gravity to the report.

The Increased Traffic of late, in dead meat, has drawn the attention of railway directors to this fact, and disposed them to afford increased accommodation for it. We hear that slaughter-houses have been established at Tiverton and Bridgewater, and that the Bristol and Exeter Company will erect others, as the demand may arise.

The Gyrometric Governor for steam engines, consists of a large metal cup which dips into water, and produces a regulating effect by its overflow. A combination of wheels is said to transmit the effect to the engine (throttle), whatever may be the amount of resistance. We have not had the opportunity yet of seeing it in action, whenever we do so, we shall be able to speak more definitely on the subject.

The Voltaic Pile.—The Corps Legislatif of France has adopted the following projected law :—Art. 1. A prize of 50,000 francs to be awarded to the author of the discovery which will render the Voltaic pile applicable, with economy, to the following purposes—To industry as a source of heat, to illuminating purposes, to chemistry, to mechanics, and to practical medicine. The rules to be adopted for the conditions and the judgment of the said competition will be determined by a decree. Art. 2. In case that no prize shall have been awarded at the period fixed by the above article, the competition can be prorogued, by a decree of the Emperor, for a new period of five years.

The Metric Decimal System of Weights and Measures.—Parliament has, as yet, passed only a permissive Act, so that their adoption is legal, if we so please. On the many advantages of the decimal system, in the commonest as in the greatest occurrences of life, we are not left to expatiate. Nor can we expect to meet with individual cases of adoption. Sir John Bowring, seconded by the Earl Fortescue, has very properly led the people of Devonshire to appreciate and adopt the excellent system. No doubt the example will be followed by the magistrates of other counties, and thus we may gradually attain the desired object.

Files.—The manufacture of files by machinery, is making rapid progress. Another company has started in this trade on a large scale in Birmingham, of which Mr. Benard Gilpin, of the Cannock Edge-tool Works, is the chairman.

Scottish Enterprise.—A telegraph cable now traverses the Firth of Forth, from Granton to Burntisland. It has been buoyed off, to prevent fouling the anchors of ships. The port of Granton is become an independent port. There are no less than six powerful steam-cranes erected on the western breakwater. This breakwater is 3,000ft. long; of which 1,800ft. may be considered as wharfs and approaches. These wharfs and approaches are expected to be continued out to the extreme end of the breakwater. The eastern breakwater will remain as such, without additions, for the present. These constructions and erections are estimated to have cost the noble house of Buccleuch upwards of £400,000.

Proposed Railway Management Act.—A Bill has been prepared by Mr. Milner Gibson, President of the Board of Trade, and Mr. Monsell, which, as it has been read the first time, in the House of Commons, it has also been printed. It does not supersede the Railway Clauses Consolidation Act of 1845, nor the Railway Clauses Consolidation (Scotland) Act 1845, but may be looked on as supplementary to these Acts. Full powers of supervision and control are afforded the Commissioners of Sewers in the City, the Metropolitan Board of Works, in other parts of the metropolis, and the High Bailiff within the City and Liberty of Westminster; wherever the works may be respectively situate. Railway bridges over streets in the metropolitan district, shall have a headway of not less than 18ft., and they are to be made ornamental, to the satisfaction of the authorities referred to. These bridges are to be made and kept watertight, and they shall also be so constructed, as to deaden, as far as practicable, the sound of traffic. Where railways are carried under streets, provision is made that the alteration in the level, or inclination of any street, interfered with, shall not exceed 1ft. in 40ft., and the width of streets shall not be diminished. Power is given to the Metropolitan Board of Works, or other authority to light arches over streets by gas, day and night, at the expense of the company. Any disturbance and re-arrangement of gas, or water mains, or pipes has to be conducted to the satisfaction of the engineer of the gas or water company concerned. There are penalties for non-compliance. As regards local rates, it is proposed that until the railway is completed and assessable, the company shall make good any deficiency in the rates, consequent upon dispossession of occupiers or other disturbing cause. Any new line of a company having *a terminus or other station within the metropolis*, shall, it is proposed, run trains to *such other outward station, as may be determined upon* from time to time *by the Board of Trade*, morning and evening, at prices not exceeding one penny for each passenger for each journey.

NAVAL ENGINEERING.

Electricity applied to Sounding.—In deep-sea sounding, the greatest difficulty is felt, even by experienced persons, in ascertaining the precise moment at which the lead of the sounding-line touches the bottom—a matter on which the whole value of the sounding depends. An apparatus, invented by M. Hedouin, of Lyons, removes every difficulty on the point. The sounding-line he employs contains within it, along its whole length, two insulated conducting-wires, the upper ends of which are connected respectively with the poles of a galvanic battery in the ship. The lead is in two parts, the lower one of which is partially inserted into the upper, and is capable of a limited vertical motion within that of the other; so that, when left to hang freely, a small empty space is left within the upper portion by the spontaneous descent, for a short distance of the lower portion. To the upper end of the lower portion, and within the upper portion, is attached a commutator, which is contained in an insulating and waterproof sheath, and which, when the lower portion of the weight is raised by contact with the ground, comes in contact with the ends of the conducting-wires, so as to complete the circuit. Instantly, by means of the ordinary electro-magnetic apparatus, a bell is rung on board the ship to attract the attention of the sounder, and a ratchet is thrown into action, which arrests the unwinding of the line from the drum on which it is coiled, so that no more can run out. This apparatus is applicable also, when the lead is kept hanging down at a certain distance from the ship, to indicate the presence of rocks or reefs, or that the water has become shallow, so as to give timely notice of approaching danger.

A Vessel Propelled by Electricity.—Great curiosity has been excited at Cherbourg by a small vessel propelled by electricity. The inventor, a French engineer, has shown his discovery to the Marquis de Chasseloup-Laubat, Minister of Marine. Another of the scientific questions has been submarine locomotion. Several trials have been made, but without much success. However, an Italian engineer, Guglielmo Giustiniani, has presented to the French government the model of a submarine boat. The French government has directed a special committee to examine and report upon the system.

Application of Electricity to Paddle-Engines.—General the Count de Molin, an Italian nobleman, has constructed and patented a paddle-engine, working by electricity, to be adapted to a small boat, christened *L'Electricité*, destined to ply on the large lake of the Bois de Boulogne. The working parts are thus composed :—There are two upright hoops, about 2ft. 6in. in diameter, placed 3in. apart, in the periphery of each of which are encased 16 electro-magnets, placed opposite each other. Between these there is another hoop or wheel, of soft iron, of the same diameter as the others, and so articulated as to receive, when alternately attracted by the magnets at each side in succession, a sort of rolling from side to side, or "waddling" motion. To this wheel is fixed an axis about 7ft. long, which forms the prime moving shaft of the machine. When the wheel between the magnets takes its rolling motion, it causes the ends of this axis to describe circles; one end turns the crank of a fly-wheel, while the other end is adapted to a framework, on the same principle as the pentagraph, which enlarges the motion received from the central disc, and communicates it in the form of a stroke by a connecting rod to a crank on the paddle shaft. This end of the moving bar also sets to work the distributers for alternately establishing and cutting off the electric communication between the magnets and the battery. There will be in all 16 elements of Bunsen's. The force of the machine while at work with four elements, was found to be one-quarter man power, so that with 16 cells, the power will be about that of a man. The paddle-wheels are 2ft. 6in. in diameter.

The Hydraulic Propeller "The Nautilus."—In The Artizan for October 1st, 1863, we enumerated some of the claims which had been set up in favour of this mode of propulsion. Our remarks were illustrated by four views. It will be recollected that water is admitted through the bottom of the vessel, which water is forced through pipes by a fan. These pipes terminate near the water line on both sides of the vessel, and in the direction of the keel by means of suitable elbows. By pointing the outflowing stream aft, the vessel is forced ahead, by the resistance of the water in which the vessel sits, to the impulsive action of the water which is forced through these pipes. Of course, a contrary effect is produced when the force of the water is made to act through other pipes suitably disposed for the purpose, with their ends pointing in a contrary direction, or forward. That all this can be accomplished, there is no doubt. The question that remains is the economy of the proposition. Some experiments have been made on the Thames, with a small craft, built for the purpose at Blackwall, and driven by two ten-horse engines. We were not present at these experiments, nor are we aware of their practical value, if they possess any. Some very long accounts have appeared in the daily papers, giving every possible particular, simply omitting the essentials. We shall soon have a man-of-war launched at Blackwall, and fitted on this principle; we may then gather some kind of data, at a money cost to the nation, which will be a lesson of the rule of thumb sort, more likely to be understood by the Admiralty and the public than any scientific explanation of the economic principles involved. In the mean time we refer those of our readers who are curious in such matters, to the illustrations and textual description already alluded to, as given in The Artizan of October, 1863.

The Torpedo.—The torpedo is not a novelty *per se*. It is an old missile in warfare. Without going into its history, we may recognise the fact that the Americans used it the other day, and with it they dealt out destruction. Our own Government made an experiment recently at Chatham with a torpedo. A ship was sunk to their satisfaction in about as short time as we take to notice the fact. The French have now repeated the experiment, in their own waters, and destroyed a frigate, the Vauban. The breach caused by the explosion of the torpedo is said to have been enormous, and what remained of the vessel, especially in the vicinity of this explosion, is described as if pierced by a mass of projectiles. That thick and solid structure was dislocated, shattered, destroyed. The copper-bolts were twisted, or driven into the surrounding wood in the most extraordinary manner. The whole frame of this large frigate was distorted, and instantly reduced to a complete wreck. A Toulon correspondent sums up in these words, "There is no plated ships nor fortification can possibly withstand the effect of this infernal machine." It would seem that this torpedo might have invited contempt for its pretensions, induced by its insignificant appearance. It weighed about fifteen pounds. Who will be rash enough to embroil countries in war, with cannon that can carry destruction for miles; with rifles that can kill, whenever the object can be distinguished; with torpedoes that annihilate whatever they come in contact with? It is thus science reduces the probabilities of war, whilst bravery and valour remain undisturbed in their more ennobling and peaceful occupations of commercial enterprise, or moral culture.

STEAM SHIPPING.

The Ardencaple, river steamer, when out on her trial trip, proved herself to be very swift and remarkably steady. She ran the Lights, against a strong head wind, at the rate of $16\frac{1}{4}$ statute miles per hour. It is expected her speed will average 17 miles per hour. She was built by Messrs. Robert Duncan and Co., of Port Glasgow, and engined by Messrs. Rankin and Blackmore, Eagle Foundry, Greenock, for the Greenock and Helmsbury Steamboat Company.

The Steamer "Agamemnon," of 2,300 tons, having 800 tons of pig iron and coals on board, sailed from Gourock Bay for Liverpool, and before putting into Liverpool, a run was made down the South Channel for the purpose of testing her. The engine is a compound, high and low pressure, the stroke being 4ft. 4in. The diameter of the high-pressure cylinder is 30in., and that of the low-pressure 62in., and with the working pressure, 65lb, the actual power of the engine is 970-horse. The diameter of the propeller is 17ft. 6in., and the mean pitch, 26ft. 6in. The boilers are fired from both ends, and are fed with fresh water (the engines being surface condensing). The consumption of fuel for the 24 hours was only 20 tons 7 cwt.; the engine made 46 revolutions per minute, working with perfect smoothness, which gave a speed of $10\frac{3}{4}$ knots per hour. This shows only a consumption of 1.96lb. fuel per hour for each actual h.p. The *Agamemnon* is to sail for China, and will be the pioneer of a line under the management of Alfred Holt, Esq., Liverpool. The builders of the steamer are Messrs. Scott and Co., and the makers of the engine, the Greenock Foundry Company.

The Cigar Boat.—The performance of this boat does not exceed the expectations of the lovers of novelty, if we are to believe the French pilot who brought to London "the cigar boat" which was built at Havre. He says her average speed was 7 to $7\frac{1}{2}$ knots an hour. She behaved exceedingly well at sea, rolling less than other vessels, which must be due rather to a judicious disposition of the weights aboard than to any stability derivable from the rotund form of her immersed transverse section.

Steam Towage in France.—At Fécamp, a steamtug, destined to be permanently employed in towing ships out of and into port, has commenced operations, and, on

the very first day, towed out as many as six large Newfoundland cod-fishing vessels, which had been waiting some time for a favourable wind. The people of Fécamp complacently felicitate themselves on their enterprise in starting the tug; but the *Journal du Havre* very sensibly remarks:—"For our part, we are astonished that a towing enterprise should not have been established at Fécamp long ago, seeing the resources the port possesses, and the need it had of such an innovation." The *Journal* afterwards goes on to complain that steam towing on the French coast has not obtained the development it ought to have. "In the vast and tortuous extent of coasts comprised between Dunkirk and Bayonne," says our contemporary, "we possess a multitude of tidal ports, which almost all offer difficulties more or less serious to the navigation of vessels which frequent them. Much more richly endowed than our neighbours, the English, as regards the number of anchorages, but much less fortunate than they are, as regards the depth of water in ports; we see that it is among them that towage is more generally practised, and that with us it is only just beginning. The exuberance of the means of towing is, in fact, so great on the other side of the Channel, that at times a captain entering a port is embarrassed less by the difficulty of getting towage than by that of making a choice between the vessels which beset him with offers of assistance at reduced rates. In France, on the contrary, the penury or absence of towage is so notorious, that it is only in our first-class ports that the chance of finding a tug can be counted on. Thus, where tugs are most necessary they are wanting, and they are superabundant where they are less needed."

New Line of Steamers between Nantes and Algiers.—In order to develop navigation between the Mediterranean and the northern ports of France, a project was some time since, set on foot in Nantes for establishing a line of steamers to ply regularly between that port and Algeria, to call at the principal ports of Portugal and Morocco, and also at Gibraltar. The scheme has obtained the support of some important houses of Nantes, and the co-operation of some capitalists at Paris has been solicited. These latter have it under consideration, and there is every probability that it will shortly be realised.

Steam Shipbuilding on the Clyde.—The *Cosmos*, a twin-screw, recently launched by Messrs. A. and J. Inglis, has made a satisfactory trial trip, having attained a speed of 10 knots per hour with 120 tons dead weight of cargo. Messrs. A. and J. Inglis have launched a saloon paddle, which is to be added to the fine fleet now plying on the Firth of Clyde. The vessel, on leaving the ways, was named the *Meg Merrilies*, and her dimensions are as follows: 196ft. keel, 23ft. beam, and 7ft. 6in. depth. She will be fitted by the builders with a pair of oscillating engines of 100 horse-power nominal. Messrs. J. and R. Swan have launched an iron screw lighter, for the Cavour Company, intended for canal traffic between Grangemouth and Port Dundas. Immediately after the launch, Messrs. Swan proceeded to lay down the keel of an iron screw steamer of about 500 tons burthen. The *Ardencaple*, the first of a new fleet of steamers built for the Greenock, Helensburgh, and Garelock steamboat traffic, has made a trial trip, in which she attained a speed of 16½ miles per hour. Messrs. Randolph, Elder, and Co. have launched a screw of 461 tons, for the Ardrossan and Belfast line; this vessel has been named the *Earl of Belfast*. Messrs. W. Denny and Brothers have launched the *Avoca*, a screw of the following dimensions: length of keel and forerake, 255ft.; breadth of beam, 32ft.; depth to spar deck, 26ft. 6in.; and burthen, 1,284 tons. The *Avoca* has been built for the Peninsular and Oriental Steam Navigation Company, and will be fitted by Messrs. Denny and Co. with engines of 250 horse-power on the direct action surface condensation principle. Messrs. Aitken and Mansel have launched a twin screw of about 300 tons burden. The dimensions of this steamer, which will be fitted with inverted cylinder engines of 50 horse-power nominal, by Messrs. Aitkin and Co., of Cranstonhill, are as follows: extreme length, 125ft.; breadth, 22ft.; depth of hold, 8ft. The vessel, which has been named the *Andrada*, has been constructed for the Angola Company (limited), and is intended to develope the trade of the River Coanza, with respect to which the Angola Company has obtained a concession of exclusive traffic facilities and privileges for twenty years, from the Portuguese Government. The company has had constructed by the same builders, a river train, consisting of a passenger and tug paddle, and five barges. These are built of steel, and are of very light draught, being intended to navigate the river 200 miles from the coast. The smaller river steamer is named the *Sa de Badeira*, after a recent Portuguese colonial minister. The Rutherglen yard has launched a paddle named the *Elvy*, 205ft. long, 20ft. beam, and 9ft. deep. The vessel is to be fitted with a pair of oscillating engines, and upright tubular boilers of 120 horse-power; she has been built to the order of Mr. R. W. Preston, and is intended for the Liverpool and Rhyl station. The Clyde steamer, *Eagle*, has made a trip after having been lengthened 16ft. abaft, and having received a thorough overhaul; she attained a speed at nearly 19 miles per hour.

Shipbuilding in New York.—There are at present being built at the shipyards of New York three of the largest steamers ever constructed in the United States. The *Bristol*, intended to run on the waters of the Sound. Her measurement is: length, 360ft. width, 48ft.; depth, 16ft. She is modelled for light draught and great speed, her strength being well preserved throughout. The *Providence* is a twin sister in every respect to the *Bristol*. These fine vessels, it is said, are in model and build, the inventions of Mr. Webb, and will prove a triumph of his skill as a shipbuilder. The *Bristol* is expected to be launched in a few days, and the *Providence* shortly after. The third steamer is being constructed for the Pacific Mail Steamship Company. Her dimensions are: length, 348ft.; breadth, 31ft.; and depth of hold, 24ft. She is intended to run from San Francisco, on the South Pacific coast, stopping at China and Japan. It is claimed that she will be one of the finest steamers ever built for ocean traffic.

LAUNCHES.

There was launched on the 20th ult., from the building-yard of Messrs. Kirkpatrick M'Intyre, and Co., Port Glasgow, a saloon river steamer, built for the Greenock and Helensburgh Steamboat Company, for the ferry traffic between Greenock and Helensburgh. This vessel is the third launched for the same company, and her dimensions are —150ft. by 16ft. by 6ft. 4in., and she measures 191 tons B.M. She is to be engined by Messrs. Rankin and Blackmore, Eagle Foundry, Greenock. She was named *Levan*.

The Screw Steamer Miranda, built for George Lawson, Esq., by Messrs. C. and W. Earl, was recently launched from their yard at Hull. She is 185ft. long, 28ft. 6in. in breadth, and 16ft. in depth: her tonnage is 670 tons, and her engines are of 100 horse-power.

On the 23rd ult., there was launched from the shipbuilding premises of Messrs. Henderson, Coulbourn, and Co., at Renfrew, a new screw steamer of 700 tons, to be fitted with a pair of direct-acting engines of 100 horse-power. She has been constructed to the order of H. L. Seligmann, Esq., of Glasgow, and is intended for the trade between London and Norway. The vessel was named the *North Star*.

There was launched from the building yard of Messrs. Randolph, Elder, and Co., Govan, a paddle steam ship, of 2,008 tons, builder's measurement, named the *Panama*. Her dimensions are 260ft. long, between perpendiculars, 40ft. beam, and 18ft. 6in. depth moulded. The machinery is by the same firm, on the double cylinder principle, and of 400 horse-power. She has been constructed for the Pacific Steam Navigation Co., for the mail and passenger service on the Pacific Coast of South America.

Messrs. William Denny and Bros. launched from their south yard, on the Mersey, a screw-steamship:—Length of keel and forerake, 255ft.; breadth of beam, 32ft.; depth to spar-deck, 26½ft.; tonnage, builder's, 1,284 tons. The vessel was named *Avoca*. Engines of 250 horse-power, on the direct-action and surface condensing principles, will be supplied by Messrs. Denny and Co.

Launched from the yard of Messrs. Aitken and Mansel, on the Clyde, a twin screw steamer, of about 300 tons burthen. Length extreme, 125ft.; breadth, 22ft.; depth of hold, 8ft. She is to be propelled by inverted cylinder engines of 50 horse-power, nominal, by Messrs. James Aitken and Co., Cranstonhill. This vessel has been constructed for the Angola Company (Limited), and is intended to develope the trade of the River Coanza, situated twenty miles south of the city of St. Paul de Loando.

Launched from the Rutherglen ship-yard, on the Clyde, a paddle-steamer:—205ft. long, 20ft. beam, and 9ft. deep. The vessel is to be fitted with a pair of oscillating engines and upright tubular boilers of 120 horse-power. She is intended for the Rhyl station. The vessel was named the *Elwy*.

Two powerful Steam Hoppers, built with all the most recent improvements, were very successfully launched from the building-yard of Messrs. Leckie, Wood, and Munro, Torry. It is expected that each of these hoppers will economise the manual labour employed by the Harbour Commissioners to the extent of six men. They are each provided with a 16 horse-power engine, and the measurement of the barges is as follows:—Entire length, 75ft.; breadth of beam, 17ft.; depth, 7ft. The bottom of the receptacle for containing the harbour dredgings opens downwards, for the discharge of its contents into the sea.

Launches at Preston.—On the 17th ult. two splendid vessels were launched from the yard of the Preston Iron Shipbuilding Company, at the Marsh End, Preston. Both are paddle-wheel steamers, and one of them was the largest ever built at Preston. The weather was fine, and the strong wind which had been blowing from the west for many hours drove the tide up with great force; in fact, the tidal current rose at a most extraordinary rate, and in proof of this we need only state that at one point of its progress it heightened fully 14 inches in five minutes. The altitude of the tide, according to the almanac, was 20 feet 4 inches, but the western wind which blew, drove it up considerably higher than that. The first vessel—a steel-made craft christened Jachta, by Miss Oakes, of Manchester, and built for Messrs. J. H. Forrester and Co., of Liverpool, for the service of the Pasha of Egypt on the river Nile—was launched at about half-past eleven o'clock. She took the water very nicely, amid the cheers of the spectators. Afterwards she was hauled round and towed up to the quay side. The length of the Jachta, over all, is 185ft.; her length on the water line is 170ft.; beam, 20ft.; depth, 7ft. 11in.; tonnage, 336. She has oscillating engines of 100 horse-power, nominal. In addition to three separate saloons and state rooms, she has accommodation for officers, engineers, and crew. She is the first steel vessel ever built at Preston. Her fittings are of a handsome character. The other vessel was launched at half-past twelve. She was christened the *Taurus*, by Mrs. Moss, of Liverpool. This vessel glided into her "native element" amid cheers, and as she displaced the water and showed her titanic form on its heaving surface, the scene became very imposing. The force of the wind and water, and the impetus otherwise given, caused the vessel, on returning to the side whence she had been launched, to ride up leewards too rapidly, and her motion in this direction was not stopped until she came in contact with the end of a stone wall, a portion of which was knocked down. Fortunately the vessel sustained no injury, and the alarm which her encounter created soon subsided. Afterwards she was moored at the side of the river some distance below the ship-yard. The *Taurus* is the largest vessel ever built at Preston. She has been built for the General Steam Navigation Company, London; has been specially fitted up for the cattle trade; and will sail between London and Tonning, in Denmark. Her dimensions are:—Length, over all, 260ft.; length on water line, 245ft.; beam, 32ft.; depth, 17ft.; tonnage, 1,230. Her engines are 300 horse-power, nominal. She is built entirely of iron, and her construction embraces all the recent improvements. The vessel is fitted in her hold and decks with stalls for the accommodation of 800 bullocks, and she has also space on her hurricane deck for 600 sheep. The Taurus is not only the largest vessel ever built at Preston, but is one of the finest cattle steamers afloat. After the launches, a select company of ladies and gentlemen partook of luncheon in one of the rooms connected with the Preston Iron Ship-building Company's offices. At the conclusion of the repast the usual loyal and patriotic toasts were given; then followed the health of the owners, builders, and "christener" of the vessel. In the course of the proceedings Mr. Moss gave the health of Mr. Thomas Smith, the manager. He highly eulogised Mr. Smith, and said that the Preston Ship-building Company were specially thankful to him for having launched the two vessels that day, in the face of the peculiar difficulties and under considerable disadvantage. [We understand that several of the workmen who would otherwise have assisted at the launch were out at the time on strike.] The toast was heartily drunk. Mr. Smith, in responding, said that no thanks were due for what had been effected that day, and that he and his foremen, &c., had only done their duty; and whenever occasion required it they would do it again.

The "Princess of Wales."—Messrs. Aitken and Mansel launched a saloon paddle steamer the *Princess of Wales* from their yard at Whiteinch, for the Loch Lomond Steamboat Company, 150ft. long, 16ft. 6in. broad, and 7ft. deep. This vessel is to be propelled by a pair of oscillating cylinder engines of 60 horse-power nominal, by James Aitken and Co., engineers, Glasgow.

The steam tonnage launched on the Clyde in March last, amounted to 8,523 tons.

RAILWAYS.

The Great Indian Peninsular Railway Line is now open to within forty miles of Nagpore. It is to be doubled to Chosawal.

It is expected that the junction of the Great North of Scotland with the Highland Railway and Strathspey line, which is now nearly completed, will be opened some time this month.

The Indian Government has sanctioned the despatch of a special train from Bombay, on the arrival of the overland mails. This will place Calcutta within four days post of Bombay.

The Denburn Valley Line of the Scottish North-Eastern, is expected to be ready for opening about July, 1867. The first section of the Forfar line will be taken in hand as soon as possible.

A Third Fall from the roof of the tunnel which is near the Usk station of the Monmouth, Coleford, and Usk railway, has recently occurred, which completely blocked the line.

It is found to be desirable to open up a regular communication all the year round, with any part of Canada, without touching, as at present, the United States' territory. To this end a line of railway is proposed from the eastern end of the Grand Trunk to Halifax, Nova Scotia. The proposition may be more valuable from a national and military point of view, than any other.

Facilities of Railways for Transporting Troops to or from the Metropolis—It appears that no less than 10,500 of the volunteers left London for their review an sham fight at Brighton, by the London, Brighton, and South Coast Railway. The arrangements were admitted to be most efficient. Twelve special trains were run, four between 5.20 and 5.55 a.m.; and eight between 6.20 and 7.55 a.m.

The Isle of Wight Railway is progressing satisfactorily. Eight miles are no open for traffic.

The North British Railway Company invited designs for projected improvements at the Waverley Station, Edinburgh. We understand that thirty plans have been sent in for selection.

Six Miles of the Beddgelest line are reported complete. Its total length, when finished will be nine miles. Application has been made to Parliament to authorise an amalgamation of this short line with the Cambrian Railway Company.

Steel rails are to be laid down on the Furness line. It is intended at the onset to lay down only one mile of these rails at each of the principal stations, by way of trial, and ecommencement, if successful.

The Great Western.—A report has been circulated that this railway company contemplate the erection of workshops at Carmarthen for the construction of locomotives, &c. It is likely to be a convenient spot for repairs, where there is cheap land and cheap unskilled labour; whatever more may be required, must be imported, even fuel and material.

The Paris terminus of the Western Railway in the Rue St. Lazare, formerly the Place de l'Europe, comprehends no less than thirty-one lines of rails. There were also two stone tunnels. These tunnels have been removed, and the entrance to the terminus considerably widened, and now an immense iron roof is being constructed to cover this ground.

The North London Railway Company have opened a new and very commodious station at the Stratford Branch Junction, at the extreme western end of Victoria Park. This supersedes the old station of Hackney Wick.

DOCKS, HARBOURS, BRIDGES.

Llanelly Dock.—The capabilities of the Llanelly Dock are become quite insufficient to meet the requirements of shippers. The Harbour Commissioners have, in consequence, determined to increase the accommodation by enlarging the dock. Steps are being taken to raise the necessary capital forthwith.

Aberdeen Harbour.—The Harbour Commissioners are endeavouring to secure the insertion of clauses which they consider calculated to protect the interests of the harbour in the Great North of Scotland Amalgamation Act, 1866.

Birkenhead Docks.—The new intermediate dock at Birkenhead has an area of seven and a half acres. It has been formally inspected and opened for commercial purposes. This dock has no less than three entrances from the river Mersey.

Southwark Bridge.—Negociations are pending for the purchase of Southwark Bridge, by the Bridge-house committee.

MINES, METALLURGY, &c.

Coal in Russia.—The fact will be heard with surprise by the large number who have hitherto considered that the expansion of the Russian empire was necessarily limited by the lack of coal, that the coal recources of Russia are now shown to be considerably greater than even those of the United States. In the Oural district coal has been found in numerous places both on the west and east sides of the mountain chain, its value being greatly enhanced by the fact that iron is found in its immediate neighbourhood. There is an immense basin in the district, of which Moscow is the centre, covering an area of 120,000 square miles, nearly as large as the entire bituminous coal area of the United States. And there is the coal region of the Don, covering 18,000 square miles, and being, therefore, considerably larger than the anthracite region of Pennsylvania; as large as the whole of the bituminous coal area of British America, and more than half as large again as all the coal fields in the United Kingdom. Besides the three coal regions above described (whose aggregate area equals all the coal fields of the United States, British North America, and Great Britain combined) coal has been discovered in the Caucasus, Crimea, Simbirsk, Ekatarinofski, and the steppes of the Kherson, in the government of Kief, and in Poland. These facts alone may materially interfere with the calculations which have been hazarded as to the probable duration of our coal fields, and should, at least, allay some of the anxiety as to the future coal supply for the world.

Explosions in Coal Mines.—In the *Mining Journal*, Mr. George Adcroft, of Barnsley, makes the following suggestions as to the best and safest means of preventing explosions in coal mines. In the first place, where there is any gas, lamps should be used exclusively, and not a mixture of lamps and candles. The lamps used should be Stephenson's, for the Davy is not safe. All lamps should be bought by and belong to the employers. The material of which the lamps are made should be of the best possible quality that can be obtained. They should be made in the best possible manner, with the best possible workmanship. They should be cleaned every day with flint-dust by men and boys employed by the masters. The lamps should never be allowed to be taken from the pit by the men; they should be given to them in the morning locked, and delivered up at night in the same manner. If anyone in the mine happens to have his light put out, he should be compelled to come to a certain place to have it re-lighted. Neither a manager, viewer, deputy-underlooker, nor any other person should be allowed to have a key to unlock the lamps, except those stationed at proper places. I speak particularly upon this point, because I know from experience that even deputies and managers have been imprudent at times when they have been allowed to have a key, and have unlocked lamps, where there have been explosions caused through it; whereas, if they had not had a key they could not have done it. A painted rule should be fixed at the top of the pit, where it could be seen by all the workpeople, stating that if any matches or pipes where found upon any workman's clothes he should suffer imprisonment. A question was asked at the inquest on the late explosion at Wigan—How to meet sudden outbursts of gas? I have no hesitation in saying that if the plans I have here stated were constantly carried out, with the most strict discipline amongst the workpeople, explosions need not happen, either through sudden outburst or any other cause.

A Block of Limestone of fine quality was cut at the Carrigacrump Quarries, near Rostellan, measuring 30 ft. in length, 22 ft. in width, and 7 ft. in thickness, containing 4,620 cubic feet of stone, and of the weight of 355 tons.

An Ink Mine.—A party has recently arrived at Los Angelos, from the vicinity of Buena Vista Lake and the oil springs there, having in his possession a bottle containing "a mineral substance very much resembling crude petroleum, but without any smell, and possessing all the qualities of a fine writing fluid. Several experiments were made by different persons, and all pronounced it a good quality of ink, or fluid, for writing. We dipped our pen in the fluid and wrote several lines, and could not distinguish the difference between it and the best writing fluid now in use. When first used the color is a deep, rich black, but after exposure to the air the color moderates a little, still retaining a good, and to all appearances, durable color. A company is being formed for the purpose of testing the above discovery.—*American Paper.*

An Instrument for Detecting Fire-damp in Mines.—A very ingenious and simple instrument has recently been invented for this purpose by Mr. Ansell, of the Royal Mint. Its action depends on the tendency which exists in gases and vapors to diffuse themselves through each other, notwithstanding the interposition of membranes or porous substances, &c. It consists of a small brass cylinder, one inch and a half long, and three quarters of an inch internal diameter, and of a piston working freely within. Under the piston, and within the cylinder, is a spring, which, when pressed by the sinking of the piston into the cylinder, moves a hand upon a dial on the outer case—which has a plate of porous earthenware at the back. When this instrument is brought into an atmosphere containing coal gas, the latter passes through the porous plate, and the air within the case being expended, the piston is forced into the cylinder to an extent which is indicated on the dial. Taken out of impure air, the effect will be reversed, and the index will move on the dial in the opposite direction, the exact amount of purity or contamination being indicated. It is clear that the instrument might easily be made to set a bell ringing, or give some other notice of danger from the presence of an explosive atmosphere. So far as trials of it have been made, it seems to work satisfactorily.

Trade List Prices.—It seems rather likely that the introduction of pig-makers, and of so many manufacturers of finished iron who do not pretend to adhere to the trade list of prices, will before very long lead to the discontinuance of the system, which is getting rather obsolete, of fixing an official scale of prices at all. Staffordshire can no longer rule the market; and so many Staffordshire makers sell for what they can get, that it is a question whether the official list is longer desirable. In connection with wages, whilst it furnishes a basis which was long acted upon with occasional contests, it probably now only tends to precipitate alterations in the rate of wages, which, but for the formal change of prices, often lasting only a few weeks, would not have been necessary.

Coal.—"The 9ft. seam" of steam coal has been reached in the Rhondda Valley, at a depth of 220 yards, where the vein proves to be 6ft. 3in. thick.

Wire Rope in Mines.—In Cornwall the introduction of iron wire rope has been for some time impeded by prejudice in favour of chain. Some adventurous body broke the chain and adopted the rope, and led the way to its general adoption, on the score of superior efficiency and economy. Captain Eustice, is one of those who "set his back against wire rope," he now writes from experience in the mines under his direction:—"The first cost is less, and a wire rope will last as long as three chains. . . . I shall not go into particulars respecting the various mines, but anyone who may consider it worth their notice, can be easily satisfied of the correctness of the above statements by visiting the St. Just, Marazion, or Lelant districts.

Hard Coal.—The old saying of "sending coals to Newcastle" has lately been literally carried out, one of the principal firms at Barnsley having forwarded several wagons of best "hards" to a firm at Gateshead. A good deal of coal is also being sent from the Shireoaks Colliery, in Nottinghamshire, to the ironworks at Penistone, it being considered by the company to be superior for steel-making purposes to the Barnsley or Silkstone seams, which are close at hand.

Substitute for Emery Powder.—Messrs. Bond, Russell, and Fisher, of Newport, Monmouthshire, have patented an invention embodying their discovery of a substitute for emery powder, a substance that is daily becoming scarcer and more expensive. They propose to treat the slag that is derived from blast furnaces, in such a manner as to render it available for those purposes for which emery powder is usually employed.

The Amalgamation of Gold and Silver with Mercury.—Those who have been in the Diggings" are well aware of the "sickening" and other difficulties encountered in the laborious efforts to save the gold after it has been dug up. In the year 1855 we prepared plans for securing the amalgamation more effectually. These plans would have been carried into execution had the gold mines we engaged to direct been as rich as represented. As we found they were only intended for sale, it followed that certain facts clashed with certain intentions, and our plans got obscured by dust. The metal sodium was an ingredient intended to enter into our plan of operations. We now perceive that two most able chemists, the one in New York, and the other here in London, are striving for the priority; for each has taken out a patent for his process. Their dates, however, do not go further back than 1864. Furthermore, whilst we admit their chemistry to be correct, we submit that their mode of application must undergo modification before it obtains in practice. Letters from California, where the process of these gentlemen has been tried, contain no small amount of dissatisfaction with their process, and even its abandonment in some instances. We must be excused when we lean to our own mode of application, conceiving it to be superior in practice. It originated, but was not perfected, in sight of the disappointments of amalgamation in the quartz-mills in California, in 1852.

Coal Cutting Machines.—These machines frequently occupy the attention of our ingenious men with varied success. One has at last found its way from Leeds, and is at work in the Netherton Colliery, at Northumberland. It is reported to be the most successful machine of the kind yet brought into operation. The motive power is derived from water under pressure, natural or artificial The mode of cutting the coal or shale is novel. It is totally different from the pick machines, and similar to the action of a slotting machine. The cutter carrier acts direct from the machine. The fixing of the machine to its proper locality, and its adjustment to the progress of the work is entirely self-acting. It cuts the shale which is underneath the seam, and this preserves the coal entire. It does this at the rate of 80 square feet per hour, or about 86 yards in length, by 3ft. 3in. in depth of cutting in 10 hours. One of these machines is nearly ready for operation at Cramlington, and another is ordered for Backworth Colliery.

BOILER EXPLOSIONS.

A terrific boiler explosion occurred at the Cwmfelin Tinworks, near Swansea. Five of the workpeople were killed, and four others badly injured. The Cwmfelin works are owned by Mr. David Davies, and give employment to 300 men; and as the machinery is much damaged, the works are brought to a complete stand-still. The money sacrifice—irrespective of the loss of life—is estimated at £2,500.

GAS SUPPLY.

The London Gas Companies.—Whenever the gas companies come before Parliament for enlarged powers, they are met with the opposition of owners of property in their neighbourhood. The Imperial Gas Company desire to enlarge their works at Fulham, and are most strenuously opposed The gas erections are being energetically pressed towards the outskirts.

APPLIED CHEMISTRY.

Cobalt, Nickel, and Manganese.—These metals occur frequently among our metalliferous deposits. Metallurgy has put a value on them such as to induce our miners to study them and increase their profits. The latter, manganese, occurs in well defined lodes or veins; but the two former may be adventitious only. They may occur together, even then their separation will repay the trouble. M. Terreil read a paper before the French Academy of Sciences, explaining the method proposed by him for separating these metals. To a solution of the two metals he adds ammonia, until the oxides are re-dissolved. He then heats the liquor, and to the hot solution adds a solution of permanganate of potash until the mixture remains violet, from an excess of permanganate. He then boils for a few minutes, and re-dissolves the oxide of manganese with a slight excess of hydrochloric acid. The liquor is kept hot for some hours, and then set aside for twenty-four hours. At the end of this time, all the cobalt is deposited in the form of a crystalline powder of a beautiful reddish violet colour. Of this precipitate 100 parts correspond to 22·761 of metallic cobalt, or 28·929 of the protoxide. For a very accurate determination, however, a known weight of the compound may be reduced by dry hydrogen, and the pure metal weighed.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated March 21st, 1866.

837 C. Roziere—Agents suitable for cleaning
838 M. Henry—Mariners' compasses
839 W. E. Newton—Rotary steam engines
840 F. Sage—Show cases
841 H. W. Ley—Pulleys gearing with chains
842 E. D. Elliot—Treating animal charcoal used in refining sugar
843 S. Chatwood, J. Sturgeon, and T. Sturgeon—Recording the distance run and direction of a ship or vessel

Dated March 22nd, 1866.

844 J. McNab—Apparatus for drying and stentering woven fabrics
845 W. A. Dixon—Gun cloth charges for all kinds of firearms
846 C. D. Abel—Jacquard looms for weaving cut pile fabrics double
847 J. Jackson—Breech-loading firearms
848 H. Rankin—Machinery for the manufacture of bags made of paper
849 R. A. Hardcastle—Raising and lowering heavy bodies
850 J. H. Burton—Breech-loading firearms
851 H. E. Newton—Propelling railway carriages upon inclines
852 J. Macintosh—Augmenting musical sounds
853 W. Clarke—Steam pumps
854 R. Petty—Manufacture of ropes
855 W. R. Mulley—Closing hatchway skylights of ships
856 T. E. Symonds—Construction of ships
857 M. Archdeacon—Expanding window blinds

Dated March 23rd, 1866.

858 W. Whittaker and W. Lowe—Improvements in lubricating
859 C. E. Brooman—Transforming scraps into ingots of cast steel
860 S. Moulton—Springs applicable to railway carriages
861 W. L. Winans and T. Winans—Steam engines and boilers
862 W. E. Newton—Substances used in the purification of gas
863 C. E. Amos and W. Anderson—Treating waste liquors for the dissipating of the same
864 T. Wilson—Breech-loading firearms
865 T. Ironmonger—Packing for packing pistons
866 B. Berry and G. Bromley—Screw gill boxes
867 A. Trotman, J. Trotman, and T. J. Cole—Hair and other pins
868 J. Erskine—Apparatus for filling cartridges for breech-loading firearms

Dated March 24th, 1866.

869 F. A. Calvert—Cleaning and preparing fibrous substances
870 P. Stieffel—Moderators for instruments and machinery
871 J. Buckingham—Use of a certain material to be employed in admixture with india-rubber
872 A. V. Newton—Construction of power hammer
873 A. V. Newton—Pencil for writing upon textile fabrics
874 A. V. Newton—Hoisting apparatus
875 G. T. Bousfield—Portfolios and paper files
876 J. Medhurst—Reefing and furling sails of ships
877 T. Johnston and T. W. Rennie—Arranging the wheels and trams for carriages on common roads
878 R. Newton—Generating steam in steam boilers
879 W. Boggett—Metal bolts and rods for ship building
880 W. T. Eley—Central fire breech-loading cartridges
881 T. Adams—Watch and chronometer cases
882 T. Silver—Controlling the speed of machinery
883 W. Moseley—Electrical indicator.
884 W. Moseley—Croquet balls
885 W. Moseley—Galvanic batteries

Dated March 26th, 1866.

886 J. Richardson—Breaks for stopping railway and other carriages
887 J. Ramage and T. Nelson—Blocks and plates for printing
888 S. Barbour—Finishing sewing thread

Dated March 27th, 1865.

889 J. Rawsthorne and E. H. Bayley—Carts for distributing water
890 S. H. Salom—Goggles to be used for the cure of squint
891 C. Wenner—Steam turbines
892 W. E. Gedge—Combined arm chair and travelling bag
893 W. E. Gedge—Application of metallic substances upon textile materials in the state of thread
894 F. P. Warren—Cooking apparatus
895 J. Bracher—Iron safes
896 W. A. Lyttle—Distillation of hydrocarbon
897 J. Higgin—Dyeing and printing textile fabrics
898 C. T. Liernur—Inoffensive removal of all fluids from water closets
899 W. T. Cooper—Cure of the venereal disease in the male sex
900 W. Dixon—Turning over the leaves of music
901 W. Deakin and J. B. Johnson—Gun barrels
902 J. Gamgee—Horse shoes

Dated March 28th, 1866.

903 R. M. Grassstock—Looms for weaving
904 A. A. Jaeger—Obtaining aniline yellow
905 T. Ryder—Mashing malt
906 H. J. F. H. Foveaux—Injecting fluids

Dated March 29th, 1866.

907 T. Storey and W. V. Wilson—Manufacture of leather cloth
908 J. Parkes and J. Parkes—Measuring liquids
909 M. Myers—Sifting sugar
910 H. A. Bonneville—Recovering sunken ships
911 R. Noake—Iron safes
912 W. R. Lake—Looms for weaving
913 E. Hoells, T. Renter, and O. Henrici.—Construction of bridges
914 G. T. Bousfield—Breech-loading firearms
915 J. C. Martin—Treating bones
916 G. Sturrock—Breech-loading and other firearms
917 H. E. Newton—Decorticating rice
918 J. F. C. Carle—Cramps for the use of joiners and others
919 C. Pardoe—Coke ovens

Dated March 31st, 1866.

920 W. Wray—Achromatic object glasses
921 J. Davis—Preventing the putrefactive decomposition of vegetable and animal substances
922 J. Davis—Preventing the loss of life in mines
923 G. White—Registering the variations in pressure and working of the steam in the cylinders of steam engines
924 W. Pendry—Dynamometric apparatus for relieving and indicating the strain on mooring and towing ropes or cables of ships
925 J. H. Johnson—Bleaching hooks
926 E. T. Hughes—Leather splitting machines
927 R. Hineson—Aerated waters
928 A. Bullough—Improvements in shuttles
929 J. Blair—Wearing apparel
930 G. Hindshaw—Construction of safes
931 W. Read—Electro magnetic power engines
932 S. M. Martin, S. A. Varley, and F. H. Varley—Electric telegraphs.

Dated April 2nd, 1866.

933 W. B. Collis and E. J. Collis—Coke ovens
934 E. P. H. Vaughan—Methods of solidifying the juice of the bull-t tree
935 J. J. Derricy—Machinery for the manufacture of lozenges
936 W. Hill and T. Whitehead—Machinery for dressing yarn
937 F. Legendre—Manufacture of lace
938 A. M. L. Gurtat—Obtaining colouring matters
939 C. Turner—Rotary brushing and rubbing
940 R. Dewhurst—Apparatus to be employed for sizing yards or threads
941 E. Brooke—Construction of apparatus and material for effecting the deodorising of noxious gases
942 W. Chew, J. Chew, and W. J. Lucas—Looms for weaving
943 M. P. E. Vora—Instrument called "Pipe-picker" for cleaning pipes

Dated April 3rd, 1866.

944 J. Schweitzer—Manufacture of Pancreatic emulsions of solid and liquid fats and oils
945 G. Davies—Braiding and weaving machines
946 J. M. Rowan—Apparatus for ascertaining latitude, longitude, and Greenwich time
947 C. F. Carlier—Galvanic batteries
948 C. A. Shaw—Knitting machine
949 A. G. Lock—Preparation and application of malt grains as a manure
950 G. Haseltine—Double action pianoforte
951 W. E. Newton—Power looms for weaving
952 J. Rohey—Reburning animal charcoal
953 E. C. Prentice—Preparing and treating gun cotton

Dated April 4th, 1866.

954 J. Maddocks and W. Dunn—Construction of safes
955 G. P. Wheeler—Domestic polishing powder
956 F. Wise—Effecting the combustion of fuel
957 P. J. Macaigne—Jacquard looms for weaving
958 A. A. Hely—Hydrostatic presses.
959 W. Betts—Colouring capsules
960 J. H. Johnson—Treatment of sugar
961 R. Sweeting—Labels for trucks used for the transport of goods on railways
962 W. Howitt—Construction of the roofs of horticultural and other buildings
963 M. Henry—Cutting cork
964 W. E. Newton—Carpets and other goods having a raised terry or pile face

Dated April 5th, 1866.

965 G. H. J. Simmons—Self-acting fire alarm
966 S. M. Martin and S. A. Varley—Train intercommunication
967 E. Pearson—Wearing apparel
968 A. A. Jaeger—Process for obtaining aniline red
969 F. Rebiere—Bobbin net or lace machinery
970 G. Allix—Reefing and furling sails
971 R. D. Morgan—Couplings of railway carriages
972 G. Kumbelow—Troughs for feeding pigs
973 G. Mulier—Carpenter's plates
974 S. Richards—Machinery for boring rocks
975 T. W. Pearce—Impervious concrete for covering floors
976 E. Ellison—Preventing and curing disease in cattle
977 B. Johnson—Pianofortes
978 C. J. Vieboff and J. A. Matthiessen—Steering telegraphs
979 W. Ingham—Fleshing and shaving hides
980 E. Cox—Improvements in portable dark chambers
981 F. E. Walker—Breech-loading firearms
982 W. H. Phillips—Rotary pumps
983 J. H. Johnson—Production of white or of semi-transparent glass
984 J. McNaught and W. McNaught—Washing and drying machinery
985 W. R. Taylor—Treatment of grain and raw spirit

Dated April 6th, 1866.

986 W. Cole—Elastic fabrics
987 W. Grune—Magic photography
988 J. Fraser—System for consecutively numbering cheques
989 A. Baron de Gablenz—Anti-friction bearings
990 J. Chesters—Construction of furnaces for the prevention of smoke
991 W. Cooke—Preventing or curing smoky chimneys
992 J. Young—Distilling
993 J. B. Fuller—Drawing and spinning flax
994 J. Patterson—Manufacture of double fabrics
995 T. Scott—Improvements in sinking tubes
996 C. Kendall—Atmospheric railway breaks and communications

Dated April 7th, 1866.

997 E. T. Hughes—Revolving firearms
998 C. E. Brooman—Fastening for gloves and articles
999 H. Wood—Producing ornamental surfaces on wood
1000 W. Clissold—Machinery for feeding wool
1001 A. V. Newton—Mode of and apparatus for casting railway wheels
1002 E. K. Muspratt—Burning and preparing for burning or calcining copper and other ores
1003 G. Davies—Apparatus for heating houses and apartments
1004 J. L. Davies—Looms for weaving
1005 G. Gordon—Treating animal charcoal

Dated April 9th, 1866.

1006 R. W. Thomson—Steam gauges
1007 J. Foster and J. Hollingrake—Improvements in moulding pipes
1008 J. Macintosh—Docks and apparatus connected therewith
1009 B. F. Weatherdon—Treating lucerne root for paper making
1010 F. L. Bauwens—Recovering cotton waste
1011 W. Clarke—Fastenings for trunks
1012 I. M. McGeorge and S. McGeorge—Vertically floated paddle wheel
1013 W. Rawlings and W. Rest—Fastenings for purses
1014 J. H. Johnson—Treatment of certain fatty and oily substances in order to obtain products therefrom
1015 S. J. Sherman—Hoops of ladies' skirts
1016 P. W. Hofmann—Separating sulphur from soda waste
1017 G. Davies—Process of desulphurition
1018 T. P. Tregaskis—Method of clearing rivers

Dated April 10th, 1866.

1019 R. Leake, W. Shields, and J. Beckett—Machinery for engraving and etching rollers
1020 E. Lichtenstadt—Construction of lamps suitable for burning volatile oils or spirits
1021 E. Lichenstadt—Compound volatile oil or spirit
1022 W. D. Robotham—Constructing the foundations of bridges
1023 J. Sparrow and S. Poole—Collecting the heated gases from blast furnaces
1024 W. Clarke—Improvements in crinolines
1025 J. Kennan—Bung turning lathe
1026 G. W. Skinner—Apparatus for utilising sewage matters and liquids
1027 S. W. Silver and A. Hayward—Receptacles for bottles

Dated April 11th, 1866.

1028 J. Frost—Machinery for breaking stones
1029 W. Young—Improvements in grates
1030 W. Wishart and P. Cameron—Producing loom sewed fabrics
1031 G. A. Ermeu—Preparing and spinning cotton
1032 J. Crabtree, J. Crabtree, and J. Crabtree—Washing or scouring wood
1033 J. Crofts—Breech-loading firearms
1034 T. K. Whitehead—Cleaning the roller beams of machinery used for preparing cotton
1035 W. Clark—Drawing off aerated liquors

Dated April 12th, 1866.

1036 G. Haseltine—Machine for cutting tobacco for chewing and smoking
1037 C. D. Abel—Drainage for the dwellings of towns
1038 W. Bond—Slide valves of engines worked by steam
1039 A. H. Brandon—Improvements in springs
1040 J. Haworth—Stables for horses
1041 J. J. Bodmer—Treatment of slag
1042 W. Clark—Spooling and copping threads of yarns
1043 E. Devey—Water tuyeres

Dated April 13th, 1866.

1044 H. B. James—Adhesive compositions for attaching sheathing to iron or other ships
1045 W. J. Cunningham—Drilling and ornamenting metal and other substances
1046 J. M. Macrum—Apparatus for tanning
1047 S. Chatwood—Engines for obtaining motive power
1048 W. Clark—Mills for crushing
1049 A. Swan—Evaporating or recovering lees
1050 T. Brittan—Telegraphic signalling apparatus
1051 V. S. Fombuena—Sleepers for the rails of railways
1052 J. Jefferson, C. Jefferson, L. Jefferson, M. Jefferson, and J. Greenway—Combing wool
1053 A. Jaumenne—Purifying animal and vegetable oils
1054 W. Hawdon, W. M. Hawdon, and H. Heather—Distributing valves for steam and other engines
1055 J. Gresham—Improvements in the apparatus known as Giffard's Injector

Dated April 14th, 1866.

1056 T. Cooper—Certain descriptions of locks
1057 C. Murray and M. Jennings—Machinery for kneading
1058 T. Gray—Manufacture of soap
1059 J. Jordau—Improvements applicable to steam engines
1060 H. A. Bonneville—Beds for invalids
1061 H. A. Bonneville—Removing exploded cartridges from breech-loading firearms
1062 G. T. Blundell—Screw valves for water closets
1063 R. B. Legge—Printing patterns on dyed silks
1064 S. F. Schoonmaker—Machinery for breaking stones

Dated April 16th, 1866.

1065 J. Adams—Sash fasteners
1066 J. U. Zimmermann—Breech-loading firearms
1067 C. Richardson—Looms for weaving
1068 R. E. Kaulbach—Laying submarine electrical telegraphic wires
1069 A. V. Newton—Power looms
1070 S. Bennett—Sizing machines or tape legs
1071 E. Ash and T. Whitley—Machinery for combing wool
1072 J. Hayes, J. Hayes, and J. Hayes—Shaking and delivering straw
1073 J. H. Johnson—Sifting flour
1074 J. H. Johnson—Card cases
1075 G. P. Dodge—Improvements in billiard cues
1076 J. Harris—Preventing incrustation in steam boilers
1077 W. Cuthbert—Steam whistles

Dated April 17th, 1866.

1078 C. E. Brooman—Varnish for preserving wood
1079 C. E. Brooman—Crushing ores
1080 C. J. B. King—Unfermented beverage
1081 E. R. May—Lowering ships' boats
1082 T. Gray—Treating flax
1083 T. Haimes—Manufacture of tubular fabrics in warp machinery
1084 J. Dickinson—Cocks or taps for high pressure
1085 P. W. Gengembre—Stereoscopes

Dated April 18th, 1866.

1086 W. Bullough—Machinery for warping yarn
1087 C. de Caesaria—Projectiles
1088 G. White—Pipes for smoking tobacco
1089 R. Puckering—Four wheeled vehicles for common roads
1090 J. Marshall—Heating the water supplied to locomotive boilers
1091 J. G. Jones—Cutting and getting coals
1092 C. M. Barker—Distilling fatty and other matters
1093 C. A. Girard—Preparation of diphenylamine
1094 W. Y. Edwards—Axles and axle boxes for carts
1095 W. Y. Edwards—Eyeletting machines

Dated April 19th, 1866.

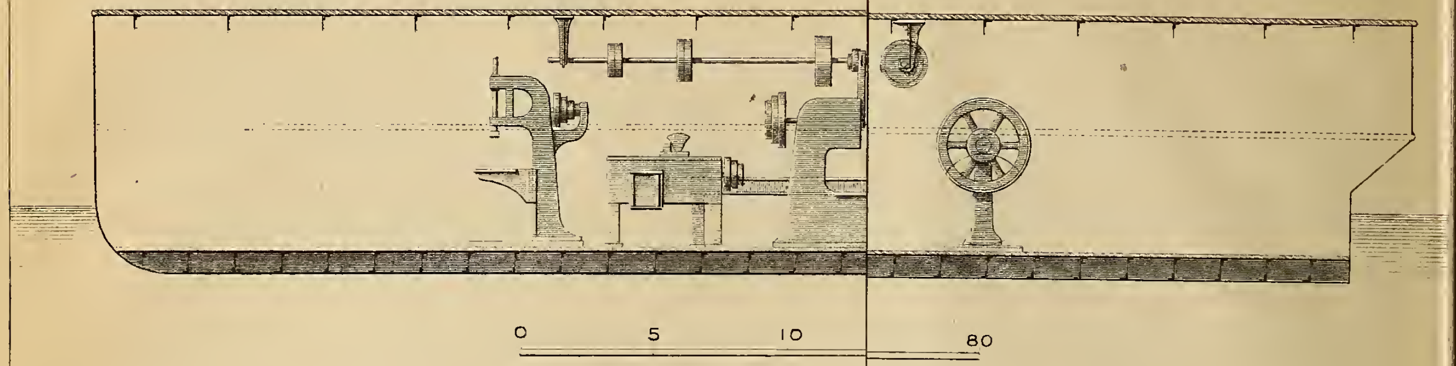
1096 E. Lord and R. Norfolk—Reaping machines
1097 J. Holmes and J. C. H. Slack—Fastenings of the metallic hoops employed in baling cotton
1098 W. Oldham, H. Penn, and C. Eccles—Collecting and utilising the fumes given off by furnaces used in the manufacture of copper
1099 E. Tuttle—Water wheels
1100 G. Beadon—Attaching knobs to the spindles of mortise and other locks or fastenings
1101 E. Wilson—Breech-loading firearms
1102 R. Hamilton—Composition for coating ships' bottoms
1103 A. Turner—Machinery for warping
1104 A. V. Newton—Bar iron and steel
1105 C. Dales—Eye glasses
1106 D. Evans—Articles made of plates of wrought iron or steel
1107 E. C. Nicholson—Blue colouring matters suitable for dyeing and printing

Dated April 20th, 1866.

1108 G. Lunge—Carbonates and bicarbonates of soda and potash
1109 W. Webb—Manufacture of ordnance
1110 D. L. Nicholas-Daubisguye and R. D. Clegg—Bottle stoppers
1111 T. Prideaux—Fire places
1112 C. Hastings, J. Briggs, J. Law, and H. Mitchell—Spinning and doubling
1113 C. J. Waddell and H. C. B. Muir—Valves for steam and other fluids
1114 F. E. Waller—Looped fabrics
1115 J. H. Johnson—Covering the mouths of bottles
1116 J. Leigh—Purification of coal gas
1117 E. T. Hughes—Boots and shoes
1118 J. Allen—Fastenings for doors
1119 W. E. Newton—Points upon railways
1120 G. Haseltine—Lighting and extinguishing street and other lamps
1121 G. Haseltine—Sheet iron
1122 T. Alderman—Signalling on and effecting communication between parts of railway trains
1123 W. Brookes—Combing wool and other fibres
1124 C. Mather—Beetling beams of beetling engines
1125 F. Ruppert—Wheel pinions for riggers driving operators

Dated April 21st, 1866.

1126 J. O. Ramsbotton—Machinery for stiffening cotton and silk woven fabrics.
1127 J. Jewsbury—Portable sun dial
1128 J. Macintosh—Guards for pocket book
1129 A. V. Newton—Grates for furnaces and fire-places



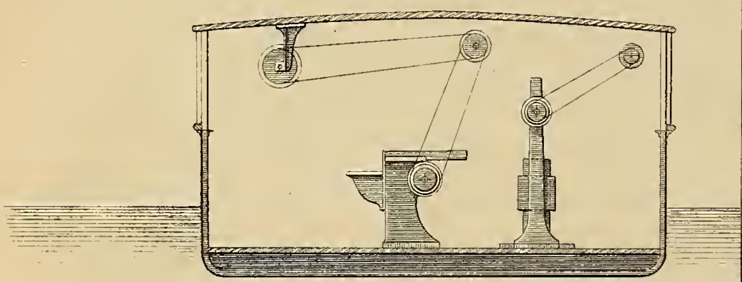
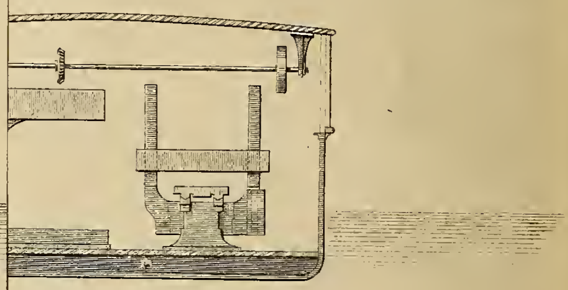
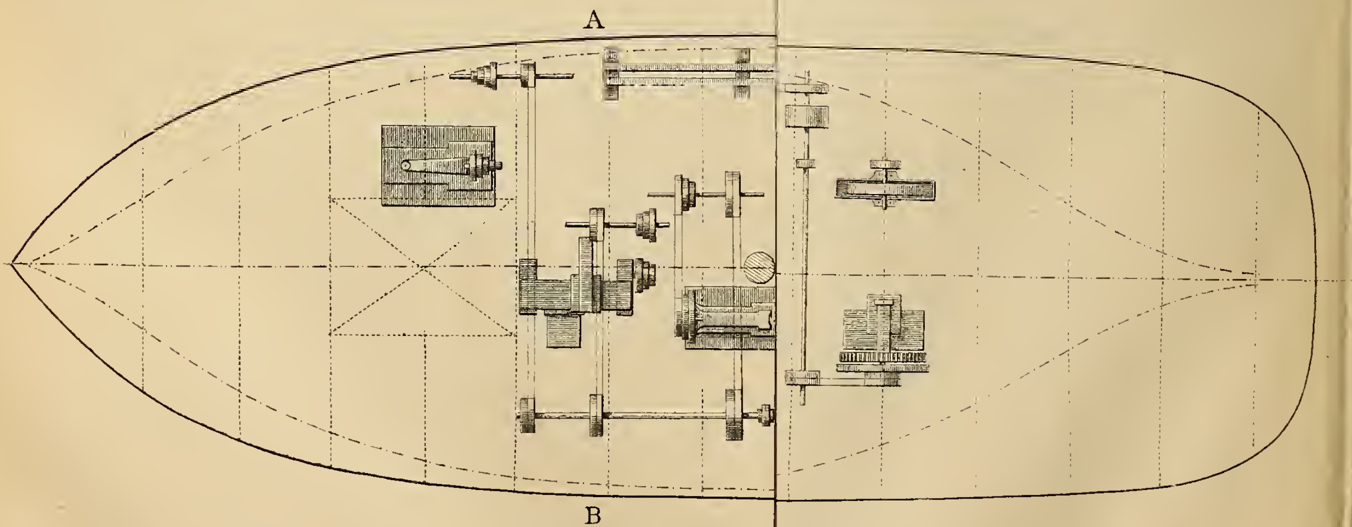


Fig 3. Section at A.B



. Section at G.H



W. Smith E.C. direx.

THE ARTIZAN.

No. 42.—Vol. 4.—Third Series.

JUNE 1st, 1866.

FLOATING WORKSHOPS FOR THE EGYPTIAN GOVERNMENT.

(*Illustrated by Plate* 301.)

In the accompanying plate we have illustrated one of a series of floating worksbops lately constructed in this country for the Egpptian government, who intend to use them for the purpose of repairing gunboats and other vessels, and probably also such machinery as they may have along the banks of the lower Nile.

The earliest specimens of floating sbops with which we are acquainted, are those built for the government of this country during the Crimean war, when a complete floating factory, comprising fitting shop, foundry, and saw mill, fitted up under the superintendence of Col. Tulloh, Capt. Collinson, R.E., and Mr. J. Anderson; and a floating corn mill and bakery, fitted up by Mr. Fairbairn, were sent out to the Black Sea, where both are known to have done useful duty. The former was described in The Artizan of October, 1855, and a description and illustration of the latter may be found in the "Transactions of the Institution of Mechanical Engineers," and thus it seems tolerably clear that tbe subject of our present illustration is not an original American idea as has been stated to us.

The workshops illustrated in the accompanying plate were designed by Mr. J. J. Birckel, from tbe subjoined specification, and the particular interest attaching to them is the fact that the boats were specially built for the purpose named, and with very small draught, to enable tbem to run into shallow waters beyond the reach of a hostile fleet.

Dimensions and particulars of boats.

Length of vessel 110ft. at water line; beam 17ft. draft, when loaded 2ft. 6in. Bottom plates from bridge up to water line $\frac{5}{16}$ Lowmoor iron, above water line tapering to $\frac{3}{16}$; to stand ten years in fresh water witbout repairs, accidents excepted, and to have columns for carrying driving shaft and supporting deck.

Engine and boiler.

High pressure engine of two cylinders 20 H.P. Boiler to burn wood, its internal tubes to be large enough so as to require only once cleaning every twenty-four hours. The boiler of Lowmoor plates $\frac{1}{2}$in. thick, to bear a working pressure of 70lbs. to be proved to the double, with proof mark of having done so engraved upon it, and with donkey engine.

Gearing for Engine.

To bave expansion gear and gearing for connecting engine with paddle and disconnecting it when working the machinery. To be tried before sending the engine and accepted on condition of its propelling the vessel three miles per hour against high tide which runs at four miles per hour.

List of Machinery required for No. 1 Workshop.

A vertical saw-frame complete, with fifteen blades, and fifteen spare blades, and fifteen spare blades 4ft. in length. A circular saw-frame complete, four changes of saws from 1ft. 6in. to 2ft. 6in. A morticing machine complete with twenty-four chisels. A band saw-frame complete, with twelve blades from $\frac{1}{2}$in. to $\frac{1}{4}$in. in width. A wood turning lathe, with gap to take in an object of 3ft. diameter. Three carpenters' benches with drill on. Six carpenters' tool chests complete. Twelve gluing up clamps. A small grindstone with frame 2ft. diameter. A portable round hearth 18in. diameter by 2ft. 6in. high.

Vessel No. 2.

Dimensions, size, and shape in every respect as No. 1; the engine also without the least variation.

List of Machinery and Tools for No. 2.

One of Schiele's noiseless fans complete, witb driving helts, pipes, and cock for working the cupola and smithy. One cupola of iron plates to be built afterwards with round bricks, diameter 3ft., witb iron chimney 10ft. above the vessel and 2,000 spare rounded hricks for renewing interior when needed. Six smith's fires, with anvils, and woodblocks under tbe anvils, each fire to be provided with two large hammers, one middle hammer with handles, eight tongs, two pokers, and other round smith's tools, four square ones and four round ones, witb tank for water. Two round portable hearths, dimensions as per No. 1. One three-ton crane complete of iron with chain, complete for moulders. One hearth and brass furnace for two crucibles, each to hold 50lbs. of metal. One core furnace made of brick and stayed with iron, and chimney high over deck. One iron tank for core material. One small grinding mill, for grinding sand and charcoal for the use of the moulders. One bench with two vices on, and small drill. Four ladles for moulders, to hold from 1 to 4 cwt. Twenty-four moulding frames, from 10in. square to 5ft. long and 3ft. wide. Twelve different tongs. Twelve iron hars for skimming, and two middle hammers. Six chisels. One moulder's box of tools complete.

Vessel, No. 3.

The same as No. 1 and 2, without any variation. Engine likewise.

List of Machinery and Tools for No. 3.

Three self-acting lathes for sliding, screwing, and surfacing, viz., one 7in. centre, one 10in. centre, and one 15in. centre. The latter with proper gap for turning or boring cylinders 4ft. diameter and 5ft. long, with self-acting boring bar, with steel centres, sliding socket, guide screw, cbange wheels, &c., with four boring heads fitted and differing in size from 18in. to 36in. Each of tbese self-acting lathes to be provided with screw bottom rest, quick hand traverse, compound slide rest, complete set of change wheels of 24, commencing from 15 or 20 teeth, and up to 150 teeth for screw cutting, Whitworth's thread, two-face plates, Clement's driver, chuck, back stay, top driving apparatus, strap lever motion, common stand and tee and universal 4-screw chuck, and each lathe to have twelve chisels and spanners with belt complete, same style as Whitworth's.

One self-acting planing machine, with self-acting tranverse motion, 3ft. wide by 6ft. 6in. long, to take in an object 4ft. high, with top driving apparatus belt, &c., complete, similar to Whitworth's, with twelve steel chisels. One small self-acting shaping and planing machine to take objects 10in. long, with self-acting transverse quick motion, and grooved foundation plate adjustable to any height up and down, with driving apparatus complete, with belt and twelve steel cbisels.

One radial drilling and boring machine with vertical slide radial arm 4ft., moveable with two drill chucks, driving apparatus, strap lever motion, and grooved foundation plate to drill up to 3in. diameter hole, with belt complete, and twelve steel drills from 1in. up to 3in.

One small vertical self-acting drilling and horing machine, with drill $1\frac{1}{2}$in., holes with grooved foundation plate adjustable vertically, driving apparatus, strap, lever motion, and belt complete, twelve steel drills from $1\frac{1}{4}$ to $1\frac{1}{2}$in.

One self-acting slotting machine to take 3ft. diameter with 6in. crank

FLOATING WORKSHOP.

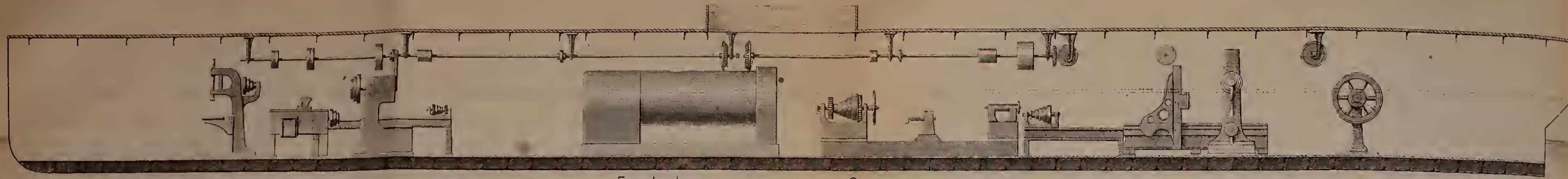


FIG 1. LONGITUDINAL SECTION

0 5 10 20 30 40 50 60 70 80

SCALE OF FEET.

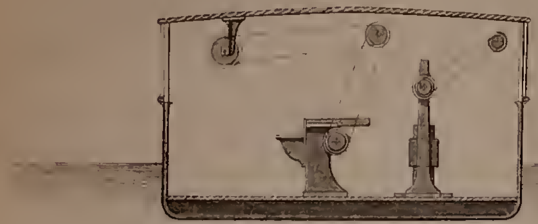


FIG 3. SECTION AT A.B

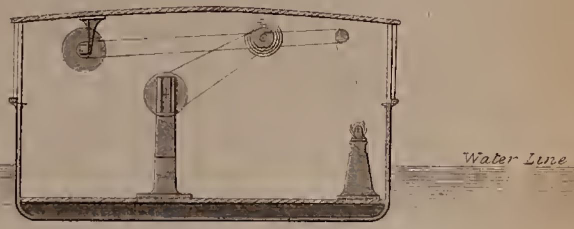


FIG 4. SECTION AT C.D

FIG 5. SECTION AT E.F

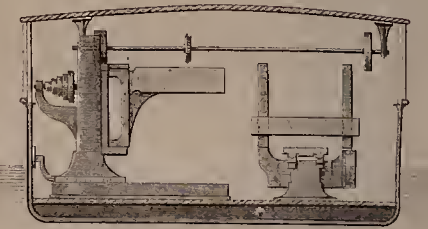


FIG 6. SECTION AT G.H

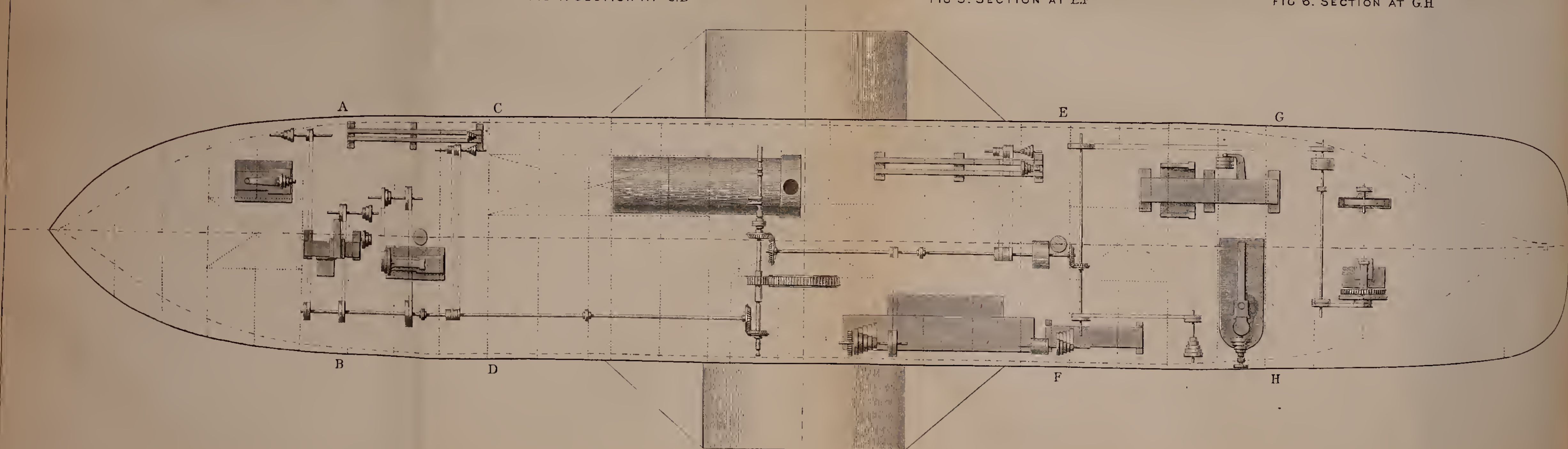


FIG 2. PLAN

W Smith E.C. direx.

with self-revolving grooved base, with driving apparatus, belt, &c., twelve chisels complete.

One self-acting single screwing machine, with driving apparatus, transverse motion, complete with 24 taps and 24 dies, Whitworth's thread from $\frac{1}{4}$in. to 2in., with belt complete.

One punching and shearing machine, the length of the shearing knife 12in. by 16in. depth, with four spare knives, twelve steel punches, and twelve dies from $\frac{3}{8}$ths to $\frac{7}{8}$ths, with driving apparatus, &c., complete. Two portable round hearths 18in. diameter, 2ft. 6in. high, one grindstone frame and six spare stones 3ft. diameter.

One bench with six vices, weighing from 75lbs. to 100lbs. with revolving small drill on.

Materials for Fitters.

One complete set of taps and dies, Whitworth's thread, with stocks, wrenches, and spanners, commencing from $\frac{1}{4}$ to $\frac{1}{2}$in., with master taps each size; one ratchet brace, two moveable spanners to 2in., six hammers, twenty-four chisels, two saw handles, and twenty-four saws for iron and brass, from 10 to 15in. long, six calipers straight, six round do., six do. with clips, four steel straight edges 2 to 4ft. long, one levelling block and two screw-jacks, one dividing marker for do., 100 doz. files assorted, half of them 15in. medium cut, and half assorted different sizes.

Tools for Rivetters and Boiler Makers.

Four rivetters' hammers, two large hammers, two holding-up hammers, four rymers with wrenches, four chisels, two snap rivetters.

The before-mentioned steamers, and their respective tools and machineries to be made of best materials and best workmanship, complete in every respect, combining recent improvements and durability.

The boats, although specified of Lowmoor plates, were built of steel, in order to obtain the greatest amount of strength possible in the small available section which could be obtained under the conditions of draught, imposed upon the builder; and as they successfully performed their voyage to Egypt, it is presumable that they are quite equal to any duty which they may have to perform hereafter.

The construction of the engines was similar to that of a locomotive engine with stationary link, with this difference only that the cylinders and motion work were placed on the top of the boiler, instead of being underneath it, and the following are their main particulars:—2 cylinders, 10in. × 16in. stroke; boiler barrel, 3ft. 9in. diameter inside × 8ft. long. Fire box 4ft. × 3ft. 10$\frac{1}{2}$in. outside. Heating surface, 60 tubes, 2$\frac{3}{8}$in. diameter outside × 8ft. 5$\frac{1}{4}$in. long = 356 sq. ft.; fire box, 54 sq. ft.; total 410 sq. ft.

ROCK OIL IN NEW SOUTH WALES.

A paper "On the occurrence and geological position of oil-bearing deposits in New South Wales," by the Rev. W. B. Clarke, M.A., F.G.S., was read on the 11th ult., before the Geological Society of London, Mr. Warrington W. Smyth, president, in the chair. The author first described the oil-producing schists and cannels of New South Wales as they exist at Colley Creek, at the head of the Cordeaux river (Illawarra shales), at various places in the Wollondilly and Natedi Valleys, at Reedy Creek (Hartley Cannel), Stoney Creek, and elsewhere; as well as a substance resembling "Bog-butter," occurring at Bournda, and probably of very recent date. Respecting the Colley Creek Cannel described in the previous paper, Mr. Clarke observed that he saw no porphyry near it, but that a seam or mass of the Cannel, which here contains numerous scarcely rounded grains of quartz, was passed through in the midst of a series of layers of black, partly unctious clay, which also contained many similar quartz grains; these grains gave to the clay a porphyritic aspect, so that by sight alone one might be led to consider them a decomposed porphyry. The chief conclusions at which the author arrived were (1) that, with the exception of the Stony Creek Cannel, all the oil-producing deposits occur in the Upper Coal Measures, and that the Cannel of Stony Creek, on the River Hunter, occurs in the Lower Coal Measures, which are above the Lower Marine beds with Trolobites, below which again are numerous fossiliferous beds before the porphyry is reached; and (2) that the Cannel belongs to beds in which Glossopteris occurs, and, therefore, may be a slight additional evidence of their antiquity, as it is an analogue of the "Bog Head" Cannel of Scotland.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.*

By R. A. Peacock, Jersey.

Introduction.

The sinkings about to be considered had not taken place as early as Ptolemy's time (the first half of the second century), but some of them had occurred before 550, for Jersey is known to have then been an island. It is mentioned also, and for the first time in history, as an island under the name of Cæsarea in the Roman Itinerary (so called of Antoninus), as Thomas Gale D.D., F.R.S., well observes in commenting on his Itinerary of Britain. The itinerary must have been added to from time to time, just as new railways are from time to time inserted in Bradshaw's Railway Guide as soon as they are opened for traffic. For it is obvious that no British Roman roads could have appeared in the Itinerary before Cæsar's first invasion of Britain B.C. 55, and it is equally obvious that the British Roman roads must have been inserted from time to time as they were made, during the 500 years of the Roman occupation of Britain. The Itinerary contains the name of Constantinople four times, though the inauguration of that city did not take place until A.D. 330, six years after its commencement. But Antoninus Pius died A.D. 161. The separation of Jersey from the continent probably took place between 150 and 350 A.D.

By the time the reader has finished the perusal of these papers, he will have noticed how unanimously all things point to one and the same conclusion—a sure test of truth.

Chapter I.

1. *Average level of the sea is stationary, it is the land which rises or sinks.* There are many instances of trunks of trees with roots attached, and of other purely terrestrial products, having been found at considerable depths below high water amongst the Channel Islands. They are generally when *in situ*, covered with sand and consequently not often visible. The wood looks fresh and not much discoloured in St. Ouen's Bay, as if it had not been immersed more than five or six centuries, which is the fact. Near St. Helier's the submarine relics of an ancient forest are mostly decayed in consequence of exposure to the weather. There is a good deal of historical evidence, which will be laid before the reader, that considerable tracts of land formerly existed where there is now only water, or bare rocks. It is equally true that there are no banks of shingle, that is of rounded pebbles, at all approaching in numbers or magnitude to the relicts of large districts which had been simply washed away; and if they had been washed away the trees must necessarily have gone also. But the trees have not gone, on the contrary, very many have remained *in situ*, consisting of greater or less portions of the trunks with roots attached, and inserted in the sea bottom where they grew, and consequently the ground has *not* been washed away. Some of these roots and stumps of trees, as well as remains of buildings, have been found evidently *in situ*, in the bed of the sea below low water, where the rise of an equinoctial spring tide is 42ft. It is out of the question to suppose that these trees could ever have grown where they were covered with salt water to that depth or nearly so, twice in every twenty-four hours. And it is also an axiom in geological science, though some geologists have forgotten it, that wherever there is any alteration in the relative levels of land and sea, the average level of the sea is always stationary, and it is necessarily the land which has risen or sunk, as the case may be. This axiom will be proved both by direct appeals to the reader's understanding, and by the deliberate opinions of distinguished geologists. For which opinions the reader is referred to Sir C. Lyell's *Manual of Geology*, 1855, p. 44, 45; and to Mr. A. B. Jukes's *Manual of Geology*, 1857, p. 203, 204. Also in the "Scheme for establishing the Royal Society," by Sir Isaac Newton; (see his life by Sir D. Brewster, vol. I, p. 91). Sir Isaac speaks of "the rising or falling of mountains and islands." Thus we see that the

greatest philosopher who ever lived, well knew that land rises and sinks. Influenced by these considerations, the present writer publicly announced in Jersey, that extensive sinkings of land had taken place since Julius Cæsar's time, and gave two public lectures to that effect in March, 1862.

2. In the deep rock cutting, or in military phrase, the "covered way," south of Fort Regent, near the town of St. Helier; are some remains of a raised beach at the top of the cliff on the west side; about 30ft. long and 8ft. thick, consisting of well rounded, water-worn pebbles. The place is well known to the inhabitants of the town as the scene of a sad accident. A few years ago a soldier and his sweetheart fell from the cliff, and were both killed. The highest part of this beach has been found by the spirit level, to be 101ft. above the highest part of the neighbouring present beach. But of course we must not suppose that the sea has ever attained 100ft. above present high water since Noah's flood. A "raised beach," means that the beach has been raised, not that the sea level has altered.

3. But there is another reason why it is quite impossible to believe that the sea has ever been 100ft. above its present level since Noah's flood. The surface of the oceans and seas comprises an area of 110,849,000 square miles.* To raise the sea level over all that surface would require about 2,100,000 cubic miles of water, for it is certain that it would be impossible to raise it in one part without raising it all over. Where could all this water have come from, or where did it go to?

4. Again, in St. Ouen's Bay, on the west of Jersey, trees have been seen *in situ*, as will presently be proved, below extreme low water where the greatest rise of tide is 42ft. And supposing them to have originally grown a little above extreme high water, we shall have a difference of about 50ft. to account for. Now, as before, we must not conclude that the sea level has ever been 50ft. lower than at present; we have no right whatever to suppose so from any records. And, physically speaking, to have brought it up to its present level would have required an accession of 1,050,000 cubic miles additional water. Where could all that water have come from?

5. Any theory of the sea level having risen 50ft. since the year 1356, which will be proved to have been the date of the submersion of St. Ouen's forest, is quite inadmissible and impossible.

6. Again, if the sea level ever was raised 100ft. (since Noah's flood), every part of every continent and island in the world which was less than 100ft. above the present sea level must have been simultaneously covered with water. But it is certain no such simultaneous catastrophe ever took place since Noah's flood. The question can be still more decisively refuted with regard to any supposed rise or fall of sea level. Thus—

7. Can the sea level rise 50ft. above its usual height at the Channel Islands without also rising about as much along the south coast of England? No.

Can the sea level rise 50ft. above its usual height along the south coast of England without also rising about as much at London Bridge? No.

If the tide rose 50ft. above its usual height at London Bridge, it would of necessity drown half London. Has such a catastrophe ever happened since Cæsar's time? No.

If the like queries are put with respect to the tide *falling short* of its usual level by 50ft. at the Channel Islands and south coast of England, the answers must still be—No.

For if the sea level was to have been 50ft. below its usual level at the mouth of the Thames, then the tide could never have entered the Thames at all. Is it true that the tide has ever failed to enter the Thames since Cæsar's time? No.

Then, if the present writer proves that the relative levels of land and sea have altered (suppose 100ft. or more) since Cæsar's time amongst the Channel Islands and on the neighbouring French coast, it will necessarily follow that the land must have risen or sunk, as the case may be? Yes.

The errors here combated have been advanced by *geologists* (amongst others) which ought never to have been the case.

* Lyell's *Principles of Geology*, 1853, p. 125.

8. The following is another of these wild impossible suppositions. The greatest rise of tide in St. Ouen's Bay is about 42ft. But a gentleman gravely suggested in reference to the fact of the late Admiral White having seen two or three stumps of trees a little below extreme low water, that though the roots were below low water, the trunks may have been above *high* water! That is to say, allowing for the roots having extended a few feet into the bottom to support the trunks and keep them above high water, the roots must have extended about 50ft. vertically downwards from the trunks. For all the world like the peasants of the Landes stalking about on their long stilts! Besides, this wild conjecture violates the facts of the case, for the remains of the trunks, as well as the roots, were below extreme low water.

9. There seems to be a great reluctance in more quarters than one to admit that any stupendous events have taken place during the historical period among the Channel Islands; and a disposition to attempt to account for the interesting phenomena about to be stated by very simple, but either totally inadequate, or totally impossible causes. These attempts have already in part, and will be from time to time set forth, to give the reader an opportunity of forming his own judgment.

10. Why should any geologists object to risings and sinkings when they well know that nothing has been, and is, more common in all ages and in every part of the world? Why should they object to a sinking of twenty, or even more, fathoms when they know that marine fossils have been found at an elevation of more than 8,000ft. in the Pyrenees, 10,000ft. in the Alps, 13,000ft. in the Andes, and above 18,000ft. in the Himalaya; Captain R. J. Strackey found oolitic fossils 18,400ft. high in the Himalaya.* And the late Professor Forbes says Illampu or Sorata (Andes) 24,812ft. high is fossiliferous to the summit.† Granted that subterranean action was, generally speaking, on a grander scale of intensity in former geological periods than it is at present: and so the immense heights named are on a grander scale than the hundred and odd feet now contended for: ought geologists who know that coal, a vegetable substance once growing on the surface of the earth, is now found at 2,000ft. and more below that surface, to object to these alleged sinkings on account of their magnitude? They know that the grander effects in ancient epochs were caused by the very same motive powers still in action at the present day. They know also that this sinking of twenty odd fathoms is not otherwise a grand event, than because it is perhaps the greatest, both in extent and depth, of any which has hitherto been known to have occurred in the historical period.

11. *The Low District Theory.*—But other views have been held than alterations of the level of the sea, and equally untenable. On the north-west of Guernsey, as we learn in a very valuable work, from the observations of a gentleman very likely to have made himself well acquainted with the facts.‡ Duncan's history states, and the present writer has personally assured himself of the accuracy of the statement, that peat is dug at very low tides.§ This peat is justly supposed to have been derived from some catastrophe affecting the coast of the island, as well as the other islands, and the neighbouring coast of France where similar events have occurred, at some unknown date or dates. Whole trunks of trees have been found imbedded in this peat, and there is no doubt this timber grew where it was found. "This district was probably extensive, and enclosed a large portion of Rocquaine Bay, the Hanways or Hanois rocks (a dangerous reef which extends about two miles from Pleinmont Point) and the extremity of the island of Lihou. It may have passed beyond the Bays of la Perelle, Vazon, Coho, the north-western limit of the Clos du Valle, including the whole extent of the Braye." The writer quoted is an accomplished geologist, naturalist, and antiquary; and he says in the "Archæological Journal" (what makes him one of my best witnesses) when speaking of a Cromlech at L'Ancresse Bay, on the north of Guernsey,

* Lyell's *Manual of Geology*, 1855, p. 4.
† *Quarterly Review*. January, 1863.
‡ Duncan's *History of Guernsey*, p. 516-17.
§ Tupper's valuable *History of Guernsey*, p. 27, gives 1750 as about the date when the peat and trees were first discovered.

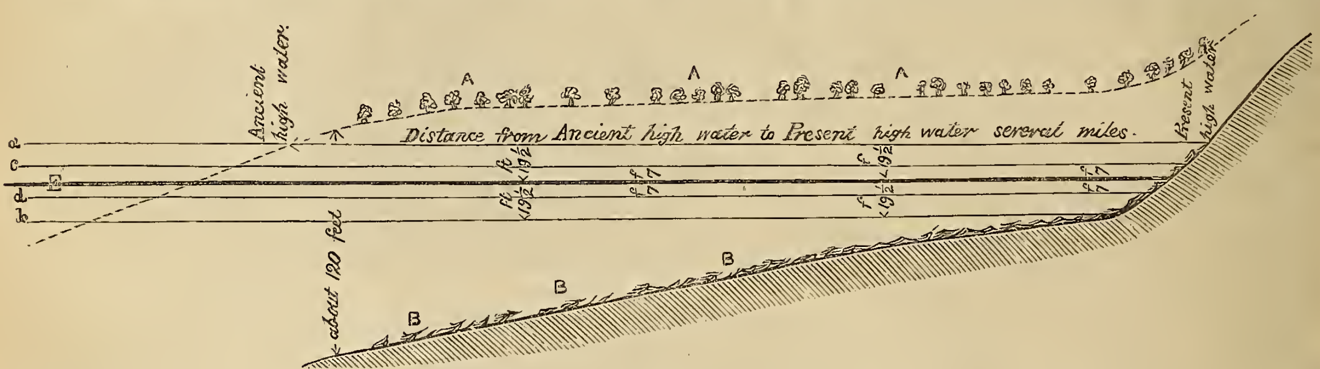
as follows:—"At the period it was constructed the sea was at a greater distance from the site of the hill than at present, for *the whole neighbourhood bears marks of the inroads of that element:* the near approach of the sandy hills around it was caused by *those events which have so materially changed the coast of these islands, as well as that of the opposite continent.*"* This district may, for the purpose of a calculation, be roughly stated (taking only that part of it which is contained within the watershed line on the chart, and its continuation by a dotted line) to have comprised a space of sea of various breadth, from a few hundred yards to a mile and a quarter wide, from the Hanois rocks (which are 1¼ miles west of the most western point of Guernsey)—along the north-western coast as far as the dotted boundary extends. We shall in due time have reasons for believing that the land extended still farther into the present sea in both directions. So far the author quoted and the present writer are agreed, but not so in respect to the sentence quoted in the following paragraph.

It is submitted to the reader that the proposition contained in the following quotation, is inadmissible, because it is impossible. He says, "that the whole [of the peat and trunks of trees] was the produce of a low district which was protected from the power of the Atlantic wave by rocks and silted materials at a certain distance from the present coast line."

Now that supposed mass of rocks and silted materials must have been watertight, else the sea water would have percolated through it, and have made the supposed low district a lake; and if so the trees could not have grown there. On the other hand, if the supposed natural embankment was watertight, we are met by another insuperable difficulty derived from the following considerations: Guernsey consists of igneous rocks like the Isle of Bute, where rain gaugings have been taken, and the produce of the streams has been measured all the year round.† The result was found to be that *a little more than half the annual rain flowed off by the brooks and streams.* That is to say, in Bute, an island very similar to Guernsey in all respects in 1826, 23·9in. out of the whole quantity of 45·4in. rain, flowed off. And applying this fact to Guernsey, where the annual rainfall averages 35in.,‡ we shall have an annual "flow" of about half a yard in depth. And assuming by way of illustration the most probable situation for part of the supposed low district and natural embankment, the latter would have extended as shown on the map, in an irregular line say five miles long from Port Pezeric, by Rocquaine, Lihou Isle, la Couchée, Modiere, to Grand Roque. And would have had an average breadth of about half a mile clear of rocks. It would follow then that the total "gathering ground" comprised between the "watershed," or summit ridge of the hills of Guernsey; and the supposed line of natural embankment (marked on the map by a broken line) would comprise 9,934 acres. This multiplied by half a yard deep would give an annual discharge of about 24 millions of cubic *yards* of water, into the supposed low district. This large quantity would have filled the supposed lake of 5 miles long and half a mile wide, to the average depth of 9ft. 3in. This is only the produce of one year. At the end of next year the depth would have been twice as great, namely, 18ft. 6in. This must necessarily have been fatal to the trees, and the low district theory ought to be abandoned.

In early life the present writer paid a fee to a firm of land-surveyors, to learn the art of measuring and mapping land. He afterwards was connected in professional business, as a civil engineer, with the late highly distinguished engineer, Robert Stephenson, F.R.S., and his scarcely less distinguished partners, Messrs. Bidder and Gooch, under whom, as engineers-in-chief, he executed many important engineering works, and is not without experience in hydraulic engineering. Those who are not familiar with the method stated, of viewing the question, are informed that calculations are made in this way by hydraulic engineers, when planning reservoirs to supply towns. A more familiar method of arriving at a conclusion, is to remember that the whole of the brooks and streams of the district, whatever their number, would have been perpetually running day and night, from year end to year end, into the supposed low district. And it is obvious that if you wish to fill a reservoir, you have only to allow a few brooks to run into it perpetually day and night.

11A. The diagram shows the nature of the change which has taken place, the tides are shown as they are at Jersey; but no particular place is intended to be represented; and the diagram is not drawn to any scale horizontally. Some thirty years ago a line of levels was very carefully carried across the peninsula, from near Lyme Regis on the English Channel, to East Quantockshead on the Bristol Channel, under the auspices of the late Professor Whewell, to ascertain if there was any, and if so, what difference in level between the half tides of the two channels. And the difference of level was found to be practically nothing. A detailed account is contained in one of the volumes of Philosophical Transactions of the Royal Society.



REFERENCE.—*a* High water; *b* low water of a Spring tide. The rise represented is 39ft., but the greatest Springs rise 42ft. at Jersey. *c* high water; *d* low water of a neap tide. Rise 14ft. *E* half tide level, *invariable.*

12. *Remarkable angularity of the marine rocks on the west and south of Jersey.*—It is observable that in the Banc du Viellet, on the south of Jersey, comprising the large extent of about ten square miles, as well as in the Bay of St. Ouen's, both which tracts of rocks, except the tops of a very few of the loftiest of them, are covered and uncovered at every tide: the rocks so covered and uncovered are more angular than rocks which are high above the sea, and have been exposed to the weather during the whole Quaternary period perhaps; though every one knows that the action of the tides, particularly in storms, is much more effective in rounding off the angles of rocks than mere weather. A gentleman suggests that pieces of stone are continually broken off the marine rocks by the violence of the sea, and that in consequence sharp angles are continually left to the rocks. To this it may be answered that it is true

* The *italics* are the present writer's. The eminent author in question thus clearly establishes the fact that great changes have taken place and diminished the extent of land.

† See Beardmore's *Hydraulic Tables*, 1852, p. xxx.

‡ The late F. C. Lukis, Esq., M.D., F.R.S. of Guernsey, kindly volunteered to send the present writer this result of about fifteen years rain gaugings.

there has been a considerable amount of breaking off of pieces of rock, but, if that were all, those pieces ought to have become rounded by the action of the sea, and there ought to have been considerable banks of *rounded* gravel; but there is nothing of the kind worth mentioning in either locality. The rocks of the Banc du Viellet consist of hornblende, granite, sienite, and porphyry, and, in St. Ouen's Bay, of crystalline clay slate. That may be observed in the case of the Banc du Viellet, which Poingdestre's statement (to be presently mentioned) naturally leads one to expect, namely, that though there are abundance of fragments chipped off, neither they nor the fixed rocks have *had time* to become rounded. You may find one in a hundred subangular, and one in five hundred rounded, or, still more rarely, an oval or elliptical pebble well rounded; but having been only exposed to the action of the sea probably since the year 1356, they are of course much less rounded than if they had been so exposed during the whole of the quaternary period. I say they were covered with soil until the ground sunk in that year, and the angles of the rocks were preserved until after the soil had been washed away, even from the action of the weather.

About Isle la Motte, or Green Island, on the south of Jersey, the angles of the rocks are less rounded though exposed to the action of the sea, than at the Fairies' Rock, a picturesque group of porphyry rocks on the mainland, some hundreds of yards north of Green Island, and quite out of reach of the sea. On the beaches themselves, the pebbles are a good deal rounded, as also the fixed rocks on their west and south, by reason of the action of the coarse sand when stirred by the waves under the influence of the prevalent winds; which is not the case (except on rare occasions) to seaward of the beach. The chimæra has been started, that Fairies' Rock has had its angles rounded by the feet of sight-seers. But on the contrary, the angles and highest points are rounded where it would be dangerous for sight-seers to go, and it is certain that people will seldom, if ever, stand on the extreme points and edges, which are the parts rounded; and even if they did so, they would be cautious and still, and exercise very little friction. Another gentleman has suggested that the phenomena under consideration, may perhaps be explained by the supposition of glacial action. But he does not attempt to show how glacial action (if it had existed) could have caused the land rocks to have been more rounded than the marine rocks, if both had been exposed for an equal length of time, which is the point in question. The present writer has examined many Jersey rocks, especially on the north side of the island, for signs of glacial action, but entirely without success. There is a good example of "slickensides," or one rock grooving another by sliding down it,—to be seen by the road side near the entrance of the village of L'Etacq. But these groovings have only been exposed to view for some half dozen years, by the rocks in front of them having been removed to widen the road. They were covered up before by other rock, and it was quite impossible for glaciers to have come in contact with them. But there is no end to these wild conjectures.

The reader is referred to the bathing rock, a large mass of granite on the beach at the south-east angle of the town of St. Helier, which is covered to half its height at high water. The top is more rounded than the eastern flank which the tide reaches. The flanks on the south and west sides are as much rounded as the top, in consequence of their having been exposed to the grinding action of the sands of the beach, when stirred by the prevalent winds.

Proceeding westwards a few hundred yards, the reddish-topped tract of sienite rock opposite Roseville-street, is very angular everywhere; but it is less angular on the top which the waves seldom reach than on the flanks. As if the flanks had been covered with earth and so protected. The like may be said of the tract of rocks to the west, and also of a tract further south; and very few of the small loose pieces lying about can be said to have attained so much roundedness as even to entitle them to be called sub-angular. The like is true as to marine rocks of St. Ouen's Bay.

The Royal Geographical Society are about to publish a somewhat full abstract in their journal, of that which is about to be given in detail in these papers. The writer sent them a stereoscopic view of some beach rocks at Pontac on the south coast of Jersey (the only copy he had), which shows the angularity in question. And a local firm of photographers have promised to take more views to illustrate this very interesting fact.

13. It would be well on the present occasion to remember the words of Hesiod, "*Πιστις δἄρἄ ὀμῶς καὶ απιστὶα ωλεσαν ἄνδρας.*"—"Faith and no faith have equally ruined men." And while we try to hit the proper medium between believing too much and believing nothing, we ought to be cautious *not* to explain away in the sense of getting rid of, and not to refuse to believe things which are quite possible and sanctioned by abundant evidence; although they may perhaps not accord with our preconceived ideas. Milton's rule which he gives in the preface to his "History of England" appears to be sound, and it will be followed in this series of papers. He says:—"That which hath received approbation from so many I have chosen not to omit. Certain or uncertain, be that upon the credit of those whom I must follow. So far as keeps aloof from impossible and absurd, attested by ancient writers from books more ancient, I refuse not, as the due and proper subject of story."

Everything appears to have been honestly related in the present case, and one circumstance often corroborates another preceding. And there certainly has not been a grand conspiracy amongst chroniclers and historians, continued through nineteen centuries, to forge records for the purpose of deceiving posterity.

At the same time we ought to remembers with the illustrious Polybius,* that it is in vain to attempt to gather history from individual circumstances. He says, "Particular relations are by no means capable of yielding any clear or extensive view into general history; the only method which can render this kind of study both entertaining and instructive, is that which draws together all the several events, and ranges them in their due place and order, distinguishing also their connection and their difference." He very justly compares the study of a particular history, to the study of a particular member of the human body. In either case, we should certainly fail to obtain a complete knowledge of the whole.

NOTE.—Notwithstanding the answers to objections and the general clearing of the ground in this paper; the facts to be stated are so extraordinary that the writer has felt it desirable that as little as possible should depend only on his own *ipse dixit.* He has, therefore, copied out many important passages from classical, middle age, and modern authors, as guarantees of his good faith in correctly quoting and faithfully translating; which passages he therefore calls voucher A, B, &c. But it would not be fitting to load the columns of *The Artizan* with Greek, Latin, and old French. Translations of the whole, or great part of them, will be given. And the vouchers themselves can be printed as an appendix, if ever the demand should arise for the republication of the Memoir in a volume.

STEAM, VOLCANOES, AND EARTHQUAKES.

By R. A. PEACOCK, C.E.

The following extract from the *Illustrated London News,* May 12th, p. 470, refers to something which occurred at the Geological Society, in reference to the present eruption at Neo Kaimeni.

"M. Fouque's observations tend to support M. St. Claire Deville's law, that there exists a certain relation between the degree of intensity of a volcano in action and the nature of the volatile elements ejected. In an eruption of maximum intensity common salt, and salts of soda and potash predominate; in one of the second order, hydrochloric acid and chloride of iron; in one of the third degree, sulphuric acid and salts of ammonia; and in the fourth or most feeble phase, steam only, with carbonic acid and combustible gases."

On the contrary, it would appear that steam was the active agent in the

* Polybius, a Greek historian, died about 124 B.C. Many statues were erected to him.

following two volcanic explosions, which were clearly of first-class intensity. And there is no mention of either common salt, and salts of soda and potash; or of hydrochloric acid and chloride of iron; which have been supposed to predominate, respectively, in explosions of the greatest, and next greatest degrees of intensity. The following extract is from Sir Charles Lyell's "Principles of Geology," 1853, p. 430, 431.

"Galongoon, Java, 1822.—The Mountain of Galangon (or Galung Gung) was in 1822, covered by a dense forest, and situated in a fruitful and thickly-peopled part of Java. There was a circular hollow at its summit, but no tradition existed of any former eruption. In July, 1822, the waters of the river Kunir, one of those which flowed from its flanks, became for a time hot and turbid. On the 8th of October following, a loud explosion was heard, the earth shook, and immense columns of hot water and boiling mud, mixed with burning brimstone, ashes, and lapilli of the size of nuts, were projected from the mountain like a water spout with such prodigious violence that large quantities fell beyond the river Taudoc, which is forty miles distant.

"The first eruption lasted nearly five hours, and on the following days, the rain fell in torrents, and the rivers, densely charged with mud, deluged the country far and wide. At the end of four days (October 12th), a second eruption occurred, more violent than the first, in which hot water and mud were again vomited, and great blocks of basalt were thrown to the distance of seven miles from the volcano. There was at the same time a violent earthquake, and in one account it is stated the face of the mountain was utterly changed, its summits broken down, and one side which had been covered with trees, became an enormous gulf in the form of a semicircle."

NITRO-GLYCERINE.

In The Artizan for May we referred to this blasting oil, and gave such particulars as had accumulated. Experiments have been made to determine the value of its pretensions. Among others, we have the following notice of experiments at Plymouth, on the celebrated lime-stone quarries which are beneath the Hoe:—A series of experiments have recently been made at the West Hoe Quarries, with a view to practically illustrate the value of Nobel's patent nitro-glycerine blasting oil. They were conducted by Mr. E. J. Wood, the representative of the patentee. The first experiment was in a 2 feet 6 inch hole, of 1½ inch bore, in a rock very little above the level of the ground. About 4 inches of oil, enclosed in a cartridge, was placed in the hole, and tamped in the ordinary way, and, on being fired, caused the displacement of an immense mass of rock; but the full effects of the explosion were not apparent, being beneath the ground. The second experiment was tried in the solid rock, in a rather more elevated, and consequently more favourable, position. The hole was 2 feet 10 inches deep, and 1¼ inch bore, in which was placed 4 inches of oil, enclosed in a cartridge as before. The effect of the explosion was to blow out the rock, and to loosen the surrounding mass right and left to a considerable extent. There was also displacement of the rock beneath; but the extent could not be ascertained, as it was beneath the ground. The third experiment was intended as a comparison with ordinary blasting by gunpowder. It was on a large block of limestone, of about 25 cwts., the hole, which was 15 inches deep, being about 18 inches from the nearest edge. The oil, to the extent of 1½ inch, was poured into the hole, and tamped with loose earth, a piece of paper being first put in to prevent the earth mixing with the oil. The result of this blast was to shatter the stone to pieces. The fourth experiment was on a stone of similar size, though apparently harder, with an ordinary charge of gunpowder. The effect of this charge was to break the stone into three pieces. The fifth experiment, which was fired simultaneously with the last, was in the solid rock, about 3 feet from the face. Into a 3-feet hole, of 1¼ inch bore, was placed 3 ounces of oil. In this case the hole was not tamped, but filled up with water. On the charge being fired, the rock in front was blown out, and a displacement caused to the depth of 6 feet. This experiment was watched with some interest, as it was considered a fair test of ordinary blasting, and the result was regarded as highly satisfactory by the scientific gentlemen present. All the holes in the above experiments were larger than would be required when the oil is used, and in this particular case Mr. Wood stated that a ½-inch bore would have answered the purpose equally well, and that a much less quantity of oil would have effected all that was desired. The next and last experiment was on a much larger scale, and the preparations for it were only witnessed by some of the more adventurous, who climbed to the top of the quarry. The hole was 9 feet in from the face of the quarry, and 8 feet 2 inches deep, the bore being 1½ inch, and 18 inches of oil was employed in the operation. Performing the same blast with gunpowder, it was estimated that ½ cwt. would have been required, and that three blasts would have been necessary. The preparation for this experiment occupied a considerable time; but certain arrangements had to be made which were unknown to the spectators underneath. At length the fuse was lighted, and in a few minutes an explosion ensued. At first it was thought the rock removed was not considerable, and the experiment had not been so successful as had been expected; but a closer examination showed that the tremendous mass of rock in front of the charge—weighing, perhaps, 100 tons—had been blown completely out. This experiment was considered by those who were enabled to make special observation as to its result a most satisfactory one, and as establishing all the claims put forward for the nitro-glycerine blasting oil. It is understood that some further experiments similar to the last are contemplated, to show what, under more favourable circumstances, may be accomplished. Our precautionary hints in The Artizan for May were important, and may not be disregarded with impunity. It appears that a large quantity of this explosive oil has been manufactured in Germany, and exported, being distributed through various channels. Recently a stop has been put to "the trade" by a series of explosions, dealing death and destruction to all around.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON THE SAFETY AND SEAWORTHINESS OF VESSELS.

By Mr. John Ferguson.

Recent events have excited an unusual amount of interest about, and inquiry into the safety and seaworthiness of vessels, and it may be well for an Institution such as this to give an expression of their opinion, as to whether any course might be adopted which would ensure greater safety to our mercantile navy, either in their build, equipment, or management. It is a fact that every year there is a great number of losses among the vessels belonging to or trading to and from this country. I am not aware that the losses are increasing in a greater ratio than the increase of shipping; still, from the greater supervision which vessels are subject to, and the improvements which are taking place in their construction and outfit, together with the application of steamers to nearly all our maritime commerce, we should expect that the casualties would be decreasing. However, we must bear in mind, that with the introduction of steamers into so many trades, there necessarily follows a system of starting on their voyages at stated times, regardless of the state of the weather; and also that, in order to keep punctually to their days of sailing, they are kept going on at times and in circumstances which may not be favourable, or even safe. To prevent as much as possible casualties to passenger steamers, the Board of Trade have appointed surveyors at the principal ports of the kingdom, who periodically inspect the machinery and hulls, granting certificates to all vessels which are fitted up with their requirements, such vessels being provided with boats, lights, and sundry other fittings specified by the Board of Trade. In addition to these, there are rules laid down defining which side vessels are to take when passing others, and also certificates are required that the compasses of iron vessels have been properly adjusted. In fact, they employ means to insure the safety of life and property from shipwreck, or other accidents, in so far as they consider it consistent to interfere with the arrangements of shipowners. To prevent vessels from being shipwrecked on our coasts, we have lighthouses to guide, storm signals to warn, and harbours of refuge to shelter. To prevent shipwreck through damage to hull and machinery, the surveyors examine that all is efficient as far as can be ascertained. To prevent loss by collision there are sailing regulations, fog horns, steam whistles, &c. To prevent loss by fire there are fire-hose, engines, &c. For prevention of loss through errors in the compasses there is the requirement of a certificate from a competent adjuster for all iron vessels. Then, in the event of accidents, they are not unmindful, that boats, life-buoys, rockets, &c., are all efficient. Still, for all the precaution and care taken, shipwrecks occur occasionally under such appalling circumstances, that we are led to ask, can nothing further be done?

The foundering of the *London* and *Amalia*, and the immense loss of life and property on our coasts during this winter, together with the inquiries instituted by the Board of Trade into the causes of the loss, especially regarding the two above-named vessels, has brought out many suggestions and opinions as to how accidents to the same class of vessels in like circumstances might be prevented, besides indicating what were the immediate causes of the destruction of these vessels. All our members must have read with painful interest the particulars given in the newspapers of the investigations as to the loss of these vessels—vessels which we have every reason to believe were strong and faithfully built and well equipped, able to stand the severe buffetings they were subject to without straining, and yet they had to succumb to what we might call trifling defects in their deck arrangements. From such events we have much to learn; and if we have arrived at the true causes of these catastrophes, it is a duty which devolves on us to discuss the subject, to see whether any remedy may be found which might tend to prevent the recurrence of such accidents. And I would notice that it is evident from the reports that the foundering of both of these vessels was preceded and accelerated by the immense body of water which was shipped on deck. In the case of the *London*, the lower part of the ports for taking water off the deck was about 16in. above the top of the deck, in con-

sequence of there being a box waterway or spirketting which extended up to that height, so that, until the decks were filled with water up to the top of that spirketting, it had no way of getting off except by the scuppers, and if these were filled up by the coals washing about the deck, then we can understand what difficulties the crew had in their endeavours to close up the engine hatch after the skylight was washed away, especially when we are informed that the coaming of the engine hatch was only about 11in. above the deck to the check, thus showing that the water on deck would be flush with the top of the permanent coaming before it could get egress by the side ports, even if the ship was lying level. The quantity of water the deck would contain below the level of the ports would probably exceed 100 tons, and this weight would be increased more than fourfold when the water would be up to the main rail. It can easily be imagined that such a weight thrown on the top of a ship would tend to make her unmanageable, besides the risk of the water breaking into the holds or engine-room through any of the deck openings, or into the poop or deck-houses; while, to aggravate the evil, it would prevent the crew from doing anything to mend matters by pumping or stopping the openings on deck. Shipbuilders and owners are aware of such results being likely to follow the carrying of a large body of water on deck, and hence in vessels intended for stormy passages provision is made for lessening the evil by having high coamings of iron at the engine-hatches, inclosed stock-hole gratings, and in some cases the front of the poops are made of iron, besides having the ports in bulwark as low as possible. Various suggestions have been made to remedy the evils complained of, such as raising the engine-hatch coamings, deck pumps, and sounding-rod tubes to a considerable distance above the deck; and some people are of opinion that the great length of steamers in proportion to their breadth causes them to be less seaworthy than if they were broader or shorter. It may be an evil to make vessels of extreme proportions of length to breadth, inasmuch as that the weight of the upper part of the vessel is increased by the additional strength required; but I am not aware that vessels built of iron, of the usual proportions and construction, are more liable to founder than shorter vessels.

If we are correct in our inferences drawn, from the reports of the loss of the *London* and *Amalia*, viz., that their destruction was accelerated by the masses of water which they took in on deck, we would naturally conclude that if vessels were so constructed as to be free from the liability to retain water on deck, then they would be free from the liability to founder under similar circumstances. It is the opinion of many that if our large steamers which have to sail in all weathers, had spar-decks, the evil of having the main decks filled with water would be overcome, as in vessels of that construction the water could have no lodgment on the upper deck, and as prevention is better than cure, it surely must be safer to keep the body of water off the top of the vessel than to have it remaining on, especially when its presence is attended at times with such disastrous consequences. It may be unnecessary to describe the points of difference between a spar-deck ship and one with an ordinary main deck, further than to state that most of our large steamers which carry passengers, and have no spar-deck, have poop and forecastle, or deckhouses, amidships, all above the main deck; some have poop, forecastle, and deckhouses arranged so that the vessel is nearly covered in excepting in the part between the poop and the forecastle, bounded by the bulwarks on the one side and the deckhouses on the other. This open space is where any body of water which breaks on board lodges, and where in being confined it is so injurious. In such ships the crew are accommodated generally under the topgallant forecastle, and the officers in the midship deckhouses. In spar-decked ships the arrangement of the forecastle, officers' rooms, cabins, &c., may be precisely the same as just described, but the entire upper part of the ship is covered in, the side of the vessel being carried up to the upper beams. The spar-deck is generally surrounded with an iron railing and stanchions instead of the high close bulwarks required for the other description of vessel. The fact of the spar-deck being 7ft. to 8ft. above the main deck, shows that the sea would have to rise that additional height before it could get above the vessel; and even should it get on the spar-deck, there are no barriers to prevent it getting off at once without the same risk of doing damage by breaking into poop, engine-room, coal hatches, &c., owing to the deck openings being so much above the load line, which in all cases should be regulated by the main deck. I believe that the principal barrier to the adoption of spar-decks for our large passenger steamers is, that being built in that style, they rate much higher in their tonnage than vessels with the same accommodation which have the poops, forecastle, and deckhouses. In the latter class of vessels, the tonnage of the space occupied by the crew is not included in the tonnage of the vessel, unless it exceed one-twentieth of the gross tonnage, when the excess is included in the tonnage; while in ships with spar-decks the space occupied by the crew is included in the tonnage, although the arrangement on the main deck may be precisely the same in both cases. It seems an anomaly that such should be the case, as it is manifestly unfair.

There may have been some good reason for making the law as it now stands, but it is difficult to understand why it should be continued, if it encourages a system of construction in vessels which has disadvantages, some of which I have endeavoured to enumerate. And as the Board of Trade are about to introduce some changes in the tonnage laws, as regards the measurement of steamers, it might be worthy our consideration whether we should call their attention to the matter at present.

It will be in the recollection of the members of the Scottish Shipbuilders' Association, that after the reading of a paper by Mr. Lawrie on the new measurement tonnage, a committee was appointed who memorialised the Board of Trade respecting the remission of tonnage of all spaces occupied by the crew in all vessels to an extent not exceeding one-twentieth of the gross tonnage, as at present allowed for forecastles and houses on the upper deck. This memorial was sent in 1863, and in answer the Board of Trade replied "That in the event of any further legislation on the subject of tonnage, the points to which you have directed attention will receive the careful attention of their lordships." Besides having that reply from the Secretary of the Board of Trade, Mr. Moorsom, the late Surveyor-General for Tonnage, in concluding a letter addressed to Mr. Lawrie on another part of the subject, in alluding to the question of the remission of the space appropriated to the crew, in whatever part of the ship it may be situated, whether above or below the upper deck, says—"I have much pleasure in stating that I cordially concur in the views expressed by your chairman (Mr. George Smith) on this subject, and which were so unanimously accepted by the meeting; and I thought it my duty so to express myself to the Board of Trade on their late reference to me of the papers of the Association on the question."

Thus it seems to me that if the Board of Trade and the late Surveyor-General for Tonnage were at that time favourable to the remission of the tonnage of the crew space, even although it was under the main deck, I think that when we now bring forward as an additional reason that the remission of that tonnage would encourage the constructing of vessels which I have endeavoured to show would be much more safe and seaworthy than the others before-mentioned, that at the present time, when they contemplate making alterations on the law, it would be well for us to send up a memorial on the subject without delay, asking them to take the subject into consideration.

The overloading of vessels is another subject which has lately been brought prominently before the public, and it seems to have been under the consideration of the Board of Trade, as to whether they should exercise any control over the loading of vessels, as reported in the newspapers. Mr. Milner Gibson, President of the Board of Trade, in reply to a question put to him in the House of Commons, said—"In consequence of the reports on the loss of the *London* and *Amalia*, the question whether the deep sea line could be permanently marked on all vessels carrying passengers and merchandise had been considered by the Board of Trade, but the difficulties were found to be insuperable, the Government officials having no means of marking the deep water line applicable to all circumstances, or of deciding how deeply a vessel may with safety be immersed in the water."

There is no doubt but there may be difficulties in the way of determining the depth to which vessels should be loaded; but if it is a fact that the loss of many a vessel may be traced to overloading, it is surely worthy of an effort being made to arrive at what would be a fair depth to which vessels might be loaded. The underwriters recommend that ships should have three inches of side from the top of the deck to the deep load line for every foot of depth in hold; but we fear that in many cases such a recommendation has no weight or authority.

In steamers which carry a large quantity of fuel for long voyages, and which by the consumption of fuel are getting lighter every day, it is not so easy to define the depth at which they should leave port. But surely our steamship owners could give sufficient data as to what has proved to be safe immersions. This, with the information from other sources, might decide on the depth to which vessels could be safely loaded to, according to the season of the year. It might be a question for our consideration whether the draft should be regulated by the depth of hold amidships, or whether the sheer or height forward and aft should be taken along with the midship depth, or in vessels with a great breadth in proportion to their depth, perhaps the breadth ought to form an element in determining the deep load line. There may be some other elements to be taken into account, and I believe that if we could suggest any reasonable proposal to the Board of Trade it would receive their favourable consideration.

In reference to the large number of wrecks which have taken place on our coasts during the past winter, they were nearly all sailing vessels driven on shore by stress of weather. And we see that steps are being taken for the erection of a lighthouse at a part of Western Islands where it cannot fail to be of service to vessels driven towards that dangerous coast. I think also that the erection of a breakwater in Lochindaul, Islay, would be the means of giving shelter to many vessels which are obliged to try for shelter among the islands, when they cannot manage to get through the North Channel. Lochindaul seems to be a natural harbour of refuge, although at present it is not so safe owing to the want of some artificial shelter.

There are many cases of shipwreck or foundering through a variety of causes which it is not easy to foresee or provide against, but it is a duty which devolves on all connected with shipping to remedy defects wherever they are known to exist; and I hope the members of this institution will give the subject their best consideration.

ON THE CONNECTION OF PLATES OF IRON AND STEEL IN SHIPBUILDING, ESPECIALLY SUCH AS ARE SUBJECT TO SUDDEN TENSILE STRAINS.

By Mr. Nathaniel Barnaby,

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Much yet remains to be done to make iron shipbuilding a perfect art, and there is perhaps no one step remaining to be taken in the path of improvement more important than that of substituting a simple and efficient means of joining plates by welding, should it ever be discovered, for the present system of rivetting.

The loss of strength caused by the present system is considerable in iron, but appears to be still more serious in steel. It forms, in fact, the great bar to the introduction of this most promising material into ships of war.

I may give as an illustration of this, one or two of the many experiments which have been made by the Admiralty at Chatham Yard on Bessemer steel of the best quality.

A piece of steel 4ft. long, and 12in. broad, was cut from a half-inch plate, of which the proof strength was 33 tons per square inch. This piece was reduced

to 5 inches in width at the middle, was supported at the ends by square plates rivetted to it, as shown in Fig. 1, and was carefully centred.

The plate should have broken at $82\frac{1}{2}$ tons, and through the narrow part. It actually broke at $95\frac{3}{4}$ tons, and then, strange to say, broke through the wide part of the plate, tearing away through the rivet holes. Thus while the material in the middle of the plate withstood a strain of 38 tons per square inch, it actually broke through the holes at 16·38 tons per square inch, or less than one-half the strain.

In a precisely similar plate, differing from the other only in the fact that the rivets connecting the end pieces were $1\frac{1}{4}$ inches from the edge instead of $2\frac{1}{2}$ inches, the plate broke in a similar manner (Fig. 2) at 73 tons, which is only 15 tons per square inch of the section of steel broken. The holes in both these cases had been punched, and in order to ascertain whether these curious results were due to the injury supposed to result from punching, an exactly similar arrangement of plates was again tried, in which the holes were, as in the first, $2\frac{1}{2}$ inches from the edge, but were drilled instead of being punched. The plate then broke through the narrow part (Fig. 3) at 106·75 tons, or 47·53 tons per square inch of the steel broken. I do not propose to draw here any inferences from the experiments detailed, or from the series of which they form part, further than this, that all which I propose to say concerning the necessity of bestowing greater attention on the comparative strength of different modes of connecting plates intended to give tensile strength, is even more applicable to steel than to iron.

Admitting then, that for the present at least, we must be content to connect iron plates by rivets placed in holes punched or drilled out of the material, and therefore by the sacrifice of a considerable portion of the strength of the plate, it is manifestly the duty of the engineer and shipbuilder to study to make this connection with as little sacrifice of strength as possible.

In every such connection the tensile strength of the plates across the outer line of holes, of the butt strap or straps across the inner line of holes, and the resistance of the rivets to shearing should be all equal. Two plates may be connected, for example, by butt straps, as shown in the Figures 4, 5, 6, 7, and 8, so as to reduce the strength of the plate by one hole only.

The strength of the several parts has in this case been estimated on the assumption, verified by careful experiment at Chatham, that the shearing value of a $\frac{3}{4}$ Bowling rivet, including friction, and taken either singly or in conjunction with others, is 10 tons, and that of rivets of other diameters is in proportion to the squares of the diameters; also, that the tensile value of the iron between the holes is reduced in proportion to the number of the perforations, and that this reduction is about 25 per cent., when the holes are punched three or four diameters apart.

This description of butt strap is of no value in shipbuilding, because the stringer and tie plates, to which it might otherwise be applied, have to be perforated between the butts by rows of holes to connect them with the beams.

In such plates, in order to economize material, it is therefore desirable to reduce the amount of fastening at the beams as much as possible. I do not think it necessary to punch away for this purpose more than $\frac{1}{8}$ of the iron; the remaining strength of the iron would then probably be $\frac{7}{8} \times \frac{7}{8} = \frac{7}{9}$ths of the whole, so that the straps connecting them should also give $\frac{7}{9}$ths of the full strength of the plates. Any greater strength at the butts would, of course, be thrown away.

If the butt strap has to be caulked, this proportion of strength cannot be retained, as the rivet holes must then be placed nearer together.

Let us take, for example, the connection, by means of a butt strap, of two plates, $\frac{3}{4}$in. thick and 12in. wide, in which the rivets are 1in. diameter, and are spaced three diameters apart.

Then we punch out $\frac{1}{3}$ of the iron, reduce the strength of the remaining iron about one-fourth, and have left only $\frac{2}{3} \times \frac{3}{4} = \frac{1}{2}$.

The tensile strength of the plate at 20 tons to the inch is 180 tons, and the tensile strength through the holes about 90 tons.

If the connection is made by means of a single trap, the value of the rivets will be about 71 tons; and if by a double strap, 142 tons. No appreciable advantage could be obtained from a second row of rivets in this case, unless the spacing along the edge could be increased.

If the rivets are no nearer together than is necessary for caulking, a second or third row could give no advantage, except in enabling us to reduce the thickness of the butt straps to less than the thickness of the plate, by reducing the number of rivets in the inner row where the butt straps are obliged to break.

None of these considerations are new, but they have been so much neglected that those who are familiar with them will, I hope, justify me in thus re-stating them. But there are certain other considerations equally important, which have, I think, altogether escaped the notice os shipbuilders.

Let us suppose that we have a stringer or tie plate, the strength of which is, at the beams, and at the butts, $\frac{7}{9}$ of the full strength of the plates, and that we have no means of increasing the strength at these points. Have we any means by which we can, without altering the strength at these points, increase the tensile power of the plate? I think the answer would generally be, we have not—the strength of the tie will be measured by the strength at the weakest place, and this strength is fixed.

Now what I want to show is that this is not the case, and that we have overlooked an important element of strength, which is conducive to economy of material.

Take the case of a stringer or tie plate (fig. 9) crossing a number of beams, say 3ft. 6in. apart, at each of which the strength is reduced to $\frac{7}{9}$ths of the full strength of the plate.

If this plate is brought under the action of a steady strain it is a matter of indifference practically how many such points of weakness there may be, and how much stronger the material may be lying between the weak points. But when strains are suddenly applied, we have to consider not only the number of tons required to break the weakest section, but the amount which it would stretch before breaking. It is, in fact, the work done in producing rupture, viz.: the force applied, multiplied by the distance through which it acts, which is the true measure of the resistance to rupture.

Under these circumstances no elongation will take place in the strong parts of the plate lying between the beams: it will all be thrown on the weak points; and if any one of these be weaker in any sensible degree than the rest it will be confined to that point.

This being the case a large increase of power may be obtained by reducing the strength of the plate between the weak points to the strength at these points, or even to less than this, provided we get long uniform strength to give elongation.

To illustrate this, I beg leave to refer you to some experiments made at Chatham with armour plates, with reference to a proposal of Captain Palliser's.

The proposal was to apply to armour bolts, having screws cut on them, the well-known principle that the bolts would be strengthened at the screw-thread, and become less liable to break by a sudden jar, if the bolt, or a portion of it beyond the thread, were reduced in section to the same area as the iron left uncut at the thread.

The experiments referred to, made under my own careful observation showed—

1. That iron bolts of good quality and of uniform diameter, subjected to a steadily increasing strain, elongate before breaking about one-fifth of their original length.

2. If the diameter is not uniform, but is decreased through a portion of the length, then the reduced part elongates about one-fifth of its length before breaking, and the larger portion scarcely stretches at all.

3. If this reduced part is very short, as in the thread of a screw, the strain required to break the bolt is the same per square inch of the unstretched or original section as in the previous cases, but there is scarcely any elongation before rupture.

4. If the whole length of the bolt is made to the reduced diameter of the screw thread, so that the thread projects from the bolt, the breaking strain (gradually applied) is the same as before, but as the bolt will stretch one-fifth of its length before breaking, it becomes thereby less liable to rupture by a sudden blow, because, as already stated, the work done in producing rupture is in proportion to the weight or strain applied, multiplied by the elongation or the distance through which it is applied.

The details of one portion of these experiments were as follows:—

Four bolts were taken, all made of the best selected scrap iron, for the purpose of the experiment, and all of the same diameter, viz.:—$2\frac{1}{4}$in.; screw threads were cut in the ends of these, and nuts fitted. The other ends were formed with heads, having a length of 21in. between the heads and the nuts. The four bolts being thus as nearly alike in every respect as they could be made, two of them were reduced down on the anvil for a length of $4\frac{1}{2}$in. in the middle of their length, to a diameter of $1\frac{7}{8}$in., which was the same as that of the iron remaining within the screw threads. The other two bolts retained the full diameter throughout. They were broken in the hydraulic press, with the following results, as here tabulated:—

—	Breaking Strain in Tons.	Sq. In. in Sec. broken.	Tons per Sq. In. of this Sec.	Elongation.			Where broken.
				In. 5in.	In 15in.	In 21in.	
Bolts not reduced No. 1...	63	2·76	22·8	Nil.	$\frac{1}{4}$	$\frac{1}{4}$	At thread.
Bolts not reduced No. 2...	69	2·76	25·0	Nil.	$\frac{5}{16}$	$\frac{1}{2}$ bare	Ditto.
Bolts reduced No. 1...	64	1·67	38·33	$\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	In reduced part.
Bolts reduced No. 2...	65·5	2·07	31·58	$\frac{7}{8}$	1	$1\frac{1}{8}$	In reduced part, but at the shoulder where there was a slight defect.

The fact that the strains of greatest magnitude in a ship are sudden in their nature makes the principle under consideration one of no slight importance, because we see that by its application we are able to increase the time during which a given force must be applied in order to produce rupture.

As the material is disposed at present in iron decks, and stringer and tie plates, the plates are perforated in the lines of the beams, not only by the holes required for the rivets to attach the plating to the beams, but by the deck bolts which secure the wooden deck lying on the iron plating.

The loss from the iron punched out, and the weakening of that which remains, amounts, on the whole, to from 30 to 40 per cent. of the original strength of the plates. These lines of weakness occur at intervals of 3ft. 6in., and between them the plate has its full strength, except where a butt occurs.

The consequence of this is that when the deck is put in tension, the stretching is confined to those weak places, and the amount of work which the whole combination is capable of doing before rupture is extremely limited. In order to remedy this state of things, I propose to remove all the wooden deck fastening from these weak places, and put it on either side of the beam. The number of rivets for attaching the plating I also propose to reduce. By this means a strength of plating is obtained across the lines of rivetting of about three-fourths of the full strength of the plates. The next thing to be done is to reduce the strength of the plating between the beams to the same amount. This might be done by cutting holes in the plates; but instead of this I propose to omit the butt straps, and to arrange the plates so that in each of these spaces

there shall be a continuous series of butts and plates, in the proportion of one butt for every three plates. In addition to this reduction of material, I propose to leave intervals between the butts of about one-third the distance between the beams, so as to get long spaces of uniform strength between the beams.

The length of the intervals between the butts will be determined by the number of rivets which can be placed in the edge of the butted plate between the beam and the butt, as there must be sufficient to break the plate across the beam. A short piece of edge strip on the under side doubles the shearing value of the rivets, and allows about one-third of the distance between the beams to be omitted.

The advantages of one system over the other are, I think, the following:—

1. In the ordinary system one-fifth or one-sixth of the iron is punched away: by that proposed only one-ninth or one-tenth is punched out. There is from this cause a gain in direct tensile strength, to which must be added an increase of strength in the iron between the holes. These are together equal to about 12 per cent.

2. The strength of an iron deck under *compression* is limited, not by the area of section, but by its resistance to buckling between the beams. According to the ordinary mode this is very small, since it is quite free to bend downwards between the beams. But by spacing the deck fastening, as shown, at intervals of about 2ft. instead of 3ft. 6in., the tendency to buckling would be reduced. The wooden deck would thus, both by its own direct resistance to compression, and by the support it gives to the plates, play a most useful part in compression, although it is powerless as against extension when in connection with iron. I therefore conclude that no loss of compressive strength is incurred by the holes in the plates.

3. All the holes for receiving the deck fastening may be punched, whereas if the fastening is in the beam flanges, the holes for them must be drilled either in the plates or in the beams.

4. The expense of cutting, fitting, punching, and rivetting butt straps is avoided. Where the material employed is steel, the gain is more considerable, as all the holes in the butts of the plates and in the straps have to be drilled to prevent the injury done by punching.

5. The weight of material omitted at the butts amounts to one-seventh of the whole material employed.

6. There is a gain in strength against injury and rupture by the action of sudden forces, the amount of which is not susceptible of calculation, but which, being in proportion to the extent of the spaces of uniform strength which have been introduced, is, I think, very considerable.

The novelty of this proposal may be said to consist in so arranging the iron or other metal plates forming the flanges of girders, bridges, and other structures, or employed in decks, partial decks, stringers, or ties in a ship or vessel, as to make the tensile strength of the unperforated plates, intervening between adjacent butts, equal or nearly equal to the strength of the said intervening plates taken together with that of one of the butted plates where they are perforated, *i.e.*, across the row of holes made for the purpose of attaching the plates to the beams, angle irons, stiffeners, or other iron framing, and by this means rendering the use of butt straps in such combinations unnecessary. In other words, a section through the plates between the beams or stiffeners is made to have, without butt straps, about the same tensile strength as a section through the fastening at the beams or stiffeners, for the purpose of forming spaces of uniform tensile strength not greater than that of the weakest place in the combination. In these intervals elongation will take place (to an extent depending on their length) before the materials can be ruptured, so that an increased amount of work will require to be done by the operation of a given strain in producing rupture. Also, in increasing the resistance to rupture under sudden strains in single plates, by reducing the tensile strength throughout certain intervals between the beams, angle irons, or stiffeners, and approximating to that at the beams, angle irons, or stiffeners, by cutting out portions of the plate.

I am aware that iron decks are not used in merchant vessels, although they are in all iron war ships built for the Admiralty, and I consider it to be false economy to substitute, for such decks or partial decks, stringers on the ends of the beams, tie plates near their middle, and diagonal braces between them; as I think it clear that from the round up of the beams, and other causes, a considerable portion of this material is unable to succour the rest when the top of the ship is put in tension or compression.

The strength of wrought iron in extension and in compression is about the same, yet the bottom of the ship is usually made enormously stronger than the top.

Some iron ships, indeed, have no proper top, or only a wooden one. Much of the strength of the bottom, which might otherwise be made available in giving strength to the ship, considered as a floating girder, is thus wasted.

I indulge the hope that the economical considerations pointed out may be not only useful in lightening and strengthening ships designed for war, but in inducing private shipbuilders to introduce partial iron decks, so formed, into ships designed for commerce. I may, perhaps, be allowed to add, in conclusion, that these proposals do not form the subject of any patent.

THE ROYAL SOCIETY.

"ON UNIFORM ROTATION."

By C. W. SIEMENS, F.R.S.

The paper sets out with an inquiry into the conditions of the conical pendulum as a means of obtaining uniform rotation. This instrument, as applied by Watt to regulate the velocity of his steam engines, is shown to be defective,—first, because the regulated position of the valve depends upon the angular position of the pendulums, and therefore upon the velocity of rotation, which must be permanently changed in order to effect an adjustment of the valve; and secondly, because when the balance between force and resistance of the engine at a given velocity is disturbed, the angular position of the pendulums will not change until a power has been created in them, through acceleration of the engine, sufficient to overcome the mechanical resistance of the valve, giving rise to a series of fluctuations before a balance between the power and resistance of the engine is re-established.

These defects in Watt's centrifugal governor are shown to be obviated in the chronometric governor, an instrument which was proposed by the author of the paper twenty-three years ago, and which consists of a conical pendulum proceeding at a uniform angle of rotation, and therefore at uniform speed, which is made to act upon the regulating-valve by means of a differential motion between itself and the engine to be regulated, which latter has to accommodate itself to the rotations imposed by the independent pendulum. The differential-motion wheels are taken advantage of for imparting independent driving or sustaining power to the pendulum; and a constancy of the angle of rotation, notwithstanding unavoidable fluctuations in the sustaining-power, is secured (within certain limits) by calling into play a break, or fluid resistance, at the moment when the angle of rotation reaches a maximum, which maximum position is perpetuated by increasing the sustaining-power beyond what is strictly necessary to overcome the ordinary resistance of the pendulum.

The chronometric governor is used by the Astronomer Royal to regulate the motion of the large equatorial telescope and recording apparatus at Greenwich, in which application a very high degree of regularity is attained; but the instrument proved to be too delicate in its adjustments for ordinary steam-engine use.

After a short allusion to M. Foucault's governor, the paper enters upon the description of a new apparatus which the writer has imagined for obtaining uniform rotation, notwithstanding great variations in the driving-power, and which consists, in the main, of a parabolic cup, open at top and bottom and mounted upon a vertical axis, which cup dips with its smaller opening into a liquid contained within a casing completely enclosing the cup. It is shown that a certain angular velocity of the cup will raise the liquid (entering from below) in a parabolic curve to its upper edge or brim, and that a very slight increase of the velocity will cause actual overflow, in the form of a sheet of liquid, which, being raised and projected against the sides of the outer chamber, descends to the bath below, whence fresh liquid continually enters the cup. Without the overflow scarcely any power is required to maintain the cup, with the liquid it contains, in motion; but the moment an overflow ensues, a considerable amount of power is absorbed in raising and projecting a continuous stream of the liquid, whereby further acceleration is prevented, and nearly uniform velocity is the result. When absolute uniformity is required, the cup is not fixed upon the rotating axis, but is suspended from it by a spiral spring, which not only supports its weight, but also transmits the driving-power by its torsional moment. The cup is guided in the centre upon a helical surface, which arrangement has for its result that an increase of resistance or of driving-power produces an increased torsional action of the spring, and with it an automatic descent of the cup, sufficient to make up for the thickness of overflow required to effect the readjustment between power and resistance, without permanent increase of angular velocity.

It is shown that the density of the liquid exercises no influence upon the velocity of the cup, which velocity is expressed by the following formula,

$$n = \frac{\sqrt{2gh\left(1 + \dfrac{\rho^2}{r^2 - \cdot 293\,\rho^2}\right)}}{2r\pi}$$

in which

n signifies the number of revolutions per second,
h the height of liquid from the surface to the brim of cup,
r the radius of the brim, and
ρ the radius of lower orifice of cup;

only the rigidity of the spring must be greater when a comparatively dense liquid is employed.

In order to test the principle of action here involved, Mr. Siemens has constructed a clock consisting of a galvanic battery, an electro-magnet, and his gyrometric cup, besides the necessary reducing-wheels and hands upon a dial face, which proceeds at a uniform rate, although the driving-power may be varied between wide limits, by the introduction of artificial resistances into the electrical circuit. The instrument appears, therefore, well calculated for regulating the speed of all kinds of philosophical apparatus, and also for obtaining synchronous rotations at different places for telegraphic purposes. One of its most interesting applications is embodied in the "Gyrometric Governor" for steam-engines, of which an illustration is given. This consists of a cup of 200 millimetres diameter and the same height, which is fixed upon its vertical axis of rotation, and is enclosed in an outer chamber, containing water in such quantity that the lower extremity of the cup dips below its surface. The upper edge of the rotating cup is, in this application, surrounded by a stationary ring armed with vertical vanes, by which the overflowing liquid is arrested and directed downward, causing it to fall through a space or zone which is traversed by a number of radial and vertical blades projecting from the external surface of the rotating cup, which, in striking the falling liquid, project it with considerable force against the sides of the outer vessel, at the expense of a corresponding retarding effect on the cup, increasing its regulating-power.

The cup-spindle carries at its lower extremity a pinion, which gears into two planet-wheels at opposite points, which on their part gear into an inverted wheel surrounding the whole, which latter is fastened upon a vertical shaft in continuation of the cup-spindle, and is driven round by the engine in the opposite direction to the motion of the cup. The two intermediate or planet-wheels are attached to a rocking frame supported, but not fixed, upon the

central axis, which wheels, in rotating upon their studs, are also free to follow the impulse of either the pinion or the inverted wheel to the extent of the differential motion arising between them. The rocking frame is connected to the regulating valve of the engine, and also to the weight suspended from a horizontal arm upon the valve-spindle, tending to open the valve and at the same time to accelerate the cup to the extent of the pressure produced between the teeth of the planet-wheels and the pinion, while the engine is constantly employed to raise the weight and cut off the supply of steam. The result is that the engine has to conform absolutely to the regular motion imposed by the cup, which will be precisely the same when the engine is charged with its maximum or its minimum of resisting load.

The paper shows that the action upon the valve must take place at the moment when the balance between the power and load of the engine is disturbed, and that the readjustment will be effected notwithstanding a resistance of the valve exceeding 100 kilogrammes—a result tending towards the attainment of several important objects.

RESEARCHES ON GUN COTTON.—MEMOIR I. MANUFACTURE AND COMPOSITION OF GUN COTTON.

By F. A. Abel, F.R.S., V.P.C.S.

A review of the researches on the production, properties, and composition of gun cotton hitherto published, and a brief examination into the probable causes of the discrepancies exhibited between the results and conclusions of different experimenters, are followed in this paper by a criticism of the several steps in the system of manufacture of gun cotton, as prescribed by Baron v. Lenk.

The conclusions arrived at on this subject are founded upon carefully conducted laboratory experiments, and upon extensive manufacturing operations carried on during the last three years at the Royal Gunpowder Works, Waltham Abbey. In some of these operations v. Lenk's system of manufacture, as originally communicated to the English Government by that of Austria, was strictly followed; in others, various modifications were introduced in different stages of the manufacture—such as in the composition of the acids used, in the proportion borne by the cotton to the acids in which it remained immersed, in the duration of the treatment of cotton with the acids, and in the methods of purification to which the gun cotton was submitted.

Exception is taken to one or two points in the general system of manufacture, and directions are indicated in which they may be advantageously modified; but the general conclusion arrived at is that, although Boron v. Lenk cannot be said to have initiated any new principle as applied to the production of gun cotton, he has succeeded in so greatly perfecting the process of converting cotton into the most explosive form of pyroxyline or gun cotton, and also the methods of purification, as to render a simple attention to his clear and definite regulations alone necessary to ensure the manufacture of very uniform products, which are unquestionably much more perfect in their nature than those obtained in the earlier days of the history of gun cotton. Great stress is laid upon the fact that deviations from the prescribed process, which at first sight may appear trivial (such as a slight modification in the strength of the acids used, the neglect of proper cooling arrangements), are certain to lead to variations in the products of manufacture, affecting their explosive characters, or their permanence, or both. A considerable deviation from the normal composition, due evidently to some accidental irregularities in the course of manufacture pursued, has been exhibited occasionally by gun cotton obtained from the manufactories at Hirtenberg and Stowmarket.

The composition of gun cotton has been made the subject of a very extensive series of experiments, both analytical and synthetical. The material employed in the analytical researches consisted of ordinary products of manufacture, prepared at Waltham Abbey, and obtained from Hirtenberg and Stowmarket. The general analytical results are as follows:—

Air dry gun cotton contains very uniformly about two per cent. of water which proportion it reabsorbs rapidly from the atmosphere after desiccation. If exposed to a moist confined atmosphere, it will gradually absorb as much as six per cent. of water; but it rarely retains more than two per cent. upon re-exposure to open air.

The mineral constituents of gun cotton vary according to the quality of the water employed in its purification. The average proportion of ash furnished by gun cotton prepared at Waltham Abbey, where the water used is hard, amounts to one per cent. It should be observed that the process of "silicating" the gun cotton, which is prescribed by Von Lenk, but the value of which is not admitted, has been applied at Waltham Abbey only in special experimental operations. Its use naturally adds to the mineral constituents contained in the finished products.

The proportions of matters soluble in alcohol alone, and in mixtures of alcohol and ether, were found to be remarkably uniform in products of manufacture obtained by strictly following Von Lenk's directions. In the ordinary products from Waltham Abbey, the matter extractable by alcohol amounted to between 0·75 and 1 per cent., and consisted of a yellowish nitrogenised substance possessed of acid characters, and evidently produced from matters foreign to cellulose (which are retained by cotton fibre after its purification), and the products of oxidation which escape complete removal when the gun cotton is submitted to purification in an alkaline bath. The avarage proportion of matter extractable by ether and alcohol after the alcoholic treatment is from 1 to 1·5 per cent. This consists of one or more of the lower products obtained by the action of nitric acid upon cotton wool, the existence of which was established by Hadow. The causes of the invariable production of small proportions of these substances in the ordinary manufacturing operations, and of their existence in larger quantities in exceptional instances, have been carefully examined into. Their absolute removal from specimenss of gun cotton, purified for analytical purposes, was found to be almost impossible.

The methods employed for determining the proportions of carbon, hydrogen, and nitrogen in gun cotton, and the relative proportions of carbonic acid and nitrogen furnished by its combustion, have been very carefully tested. Four different methods of determining the carbon were employed, and forty-nine successful estimations of that element have been accomplished in a variety of products of manufacture. A number of very concordant hydrogen determinations, and eighteen direct estimations of the volumes of nitrogen furnished by the complete oxidation of gun cotton, have been made. The individual as well as the mean results obtained in these analytical experiments correspond much more closely to the requirements of the formula $C_6 H_7 N_3 O_{11} = C_6 \left\{ \begin{matrix} H_7 \\ 3\,NO_2 \end{matrix} \right\} O_5$, *tri-nitro-cellulose*, or $C_{12} H_{14} O_7, 3N_2 O_5$, *trinitric cellulose*) than to the formula recently assigned for gun cotton by Pelouze and Maury, $C_{24} H_{36} O_{18}, 5N_2 O_5$. The determinations of the comparative volumes of carbonic acid and nitrogen have furnished results closely in accordance with those of the direct determination of nitrogen.

Since the specimens of gun cotton analyzed always retained small quantities of the products soluble in ether and alcohol, it was to be expected that the proportion of nitrogen found would be slightly below, and consequently that the carbon results would be somewhat above, those which the chemically pure substance should furnish. The variations exhibited by the analytical results do not exceed such as are ascribable to the above cause.

A number of experiments were instituted with Hadow's method of determining the composition of gun cotton, which consists in reducing the latter to cotton by means of potassic sulphydride. The results show that, although the method is useful for controlling the results obtained, by determining the increase of weight which cotton sustains by treatment with nitric acid, it does not afford sufficiently definite and trustworthy data to render it applicable as a method of ascertaining the degree of perfection of manufacturing products, *i.e.* the extent of freedom of a specimen of the most explosive gun cotton from admixture with the soluble varieties.

The treatment of cotton with nitric and sulphuric acids has been varied in many ways in laboratory experiments, with the view to examine fully into the increase in weight sustained by the former, upon its conversion into the most explosive gun cotton, and to determine what circumstances may exert an influence upon the amount of increase, an acid mixture of uniform strength being employed throughout the experiments (3 parts by weight of sulphuric acid of spec. grav. 1·84, and 1 part of nitric acid of spec. grav. 1·52). The results arrived at may be briefly summed up as follows:—

Finely carded and carefully purified cotton wool will sustain an increase of weight varying between 81·8 and 82·5 upon 100 parts of cotton, if submitted for 24—48 hours to treatment with a very considerable excess (about 50 parts to 1 of cotton) of the acid mixture. Similar results may also be obtained by repeatedly treating the same sample of cotton for comparatively brief periods with fresh quantities of acid, provided this treatment be not too greatly prolonged. Lower results (somewhat above or below 78 upon 100 parts of cotton) are obtained; if the cotton be submitted to treatment with a large excess of acid for only brief or for very protracted periods, or if it be left for about 24 hours in contact with a comparatively limited proportion of acid (10 or 15 to 1 of cotton) The increase of weight which 100 *parts of pure cellulose* should sustain by *complete* conversion into a substance of the formula $C_6 H_7 N_3 O_{11}$, is 83·3; if converted completely into a substance of the composition $C_{24} H_{36} O_{18}, 5N_2 O_5$, it should sustain an increase in weight of 77·78.

There is strong evidence that the differences between the highest results furnished by carefully purified cotton wool, and the number 83·3, are to be principally ascribed to the small proportions of foreign matter still existing in the fibre at the time of its conversion.

The maximum increase of weight sustained by cotton of ordinary quality, such as is used in gun cotton manufacture, is, as might have been anticipated, below the result obtained, under similar conditions, with cotton of finer quality and more thoroughly purified. The highest numbers obtained by treatment of such cotton, in small quantities, with a considerable excess of acid, were somewhat below 181, from 100 of cotton. The increase of weight which this quality of cotton sustains is, however, more generally about 78 per cent.

Experiments are quoted which show that the attainment of lower results with cotton of ordinary quality is ascribable to the existence of higher proportions of foreign matters in the cotton under treatment.

Some quantitative manufacturing experiments yielded results considerably below those obtained with some of the same cotton in laboratory operations (171 and 176 of gun cotton having been produced from 100 of cotton). The causes of these differences are investigated and explained.

The identity in their characters, and close resemblance in composition, of the most perfect results of laboratory experiments, and of the purified products of manufacture, the close approximation frequently exhibited by the weight of the former to the theoretical demands of the formula $C_6 H_7 N_3 O_{11}$ (which may be expressed as

$$C_6 \left\{ \begin{matrix} H_7 \\ 3NO_2 \end{matrix} \right\} O_5, \text{ or } C_{12} H_{14} O_7, 3N_2 O_5),$$

and the satisfactory manner in which the unavoidable production of somewhat lower results in the manufacturing operations admits of practical demonstration, appear to afford conclusive evidence of the correctness of either of the above formulæ, as representing the composition of the most explosive gun cotton, and demonstrate satisfactorily that the material, prepared strictly according to the system of manufacture perfected by Von Lenk, consists uniformly of the substance now generally known as trinitro-cellulose, in a nearly pure condition.

INSTITUTION OF CIVIL ENGINEERS.

ON THE PERFORMANCE, WEAR, AND COST OF MAINTENANCE OF ROLLING STOCK.

By Mr. T. A. Rochussen, Assoc. Inst. C.E.

This communication related to the statistics of three Prussian railways—the Cologne-Minden, the Bergish-Maerkish, and the Rhenish—the general circumstances of which were stated to be somewhat similar. The tables embraced the particulars of the engines and of the carriages and waggons, with the expense of repairs and renewals, the work done by the engines in 1864, the cost of motive power, the repairs and renewals of engine-tyres, and the commercial results. Also the experience of the wear of tyres on the Cologne-Minden Railway for the twenty years from 1845 to 1864 inclusive, embracing the results of observations upon about 25,000 tyres, of different makes and of different materials.

It was stated that, on the Prussian railways, the iron-spoke wheels were gradually replaced by disc wheels, which at first were of wood, but latterly they were entirely of iron. The first form of iron disc, adopted in 1848, was that of a bulged star; a wrought iron plate, flanged to form the periphery of the wheel, was indented with five triangular bulges from the boss, which was cast on the plates forming the disc. This wheel had proved to be very durable, but it was noisy, and, the boss being $11\frac{1}{2}$in. in diameter, the structure was heavy. It, however, supported the tyre evenly and well, and reference was made to a pair of these wheels with iron tyres, which had run 116,000 miles without requiring turning, and being still $1\frac{5}{8}$in. thick, it was thought they would last up to 250,000 miles. In 1862, a disbed wrought iron disc wheel was introduced, the manufacture of which was both cheap and expeditious. But the fine grain iron necessary to insure a sound flanging for the periphery of the wheel made it too rigid. Attention was then directed to the means of obtaining elasticity both in the form of the disc and in the material used. Accordingly fibrous iron was employed, and the flat, or dished disc, was corrugated, the periphery being formed by a rim of fine grain angle iron, rivetted to the disc plate. Subsequently the disc and the rim were welded together, and about the same time the Bochum Company introduced steel castings, in the corrugated form, of combined disc and tyre. In the improved form of the corrugated wrought iron disc, brought out in 1864, the iron used was highly fibrous. Several slabs were forged to the shape of a double cardinal's hat. This bloom was re-heated twice, and, by frequent and quick rolling, was enlarged to about 3ft. in diameter. The rim was welded on under the steam hammer, which at the same time punched the hole in the boss for the axle, and gave the form of the wave to the disc plate. After turning up the rim the tyre was shrunk on and bolted. Since 1864, the tyre, whether of steel or of iron, had been welded on to the disc wheel by hydraulic pressure. In this form it was believed, the disc wheel offered the greatest amount of strength, the fibrous iron gave elasticity, the tyre was supported in every part, there were no joints, bolts or rivets to wear loose, and after the tyre had been worn out, it was simply necessary to turn it down to the thickness of an ordinary wheel rim and to shrink on another tyre. It was asserted that, with steel tyres, these wheels would run from 300,000 to 500,000 miles before requiring a new tyre; and that by grinding the tyres instead of turning them their life would be prolonged from 50,000 to 60,000 miles.

ON THE RESULTS OF A SERIES OF OBSERVATIONS ON THE FLOW OF WATER OFF THE GROUND, IN THE WOODBURN DISTRICT NEAR CARRICKFERGUS, IRELAND: WITH ACCURATELY RECORDED RAIN-GAUGE REGISTRIES IN THE SAME LOCALITY, FOR A PERIOD OF TWELVE MONTHS ENDING JUNE 30TH, 1865

By Mr. Robert Manning, M. Inst. C.E.

It was stated that the surface of the ground was chiefly composed of bare mountain pasture and grazing land, the surface rock being almost entirely tabular trap, overlying the chalk, with here and there patches of green sand. Three rain gauges were placed at the respective elevations of 300ft., 750ft., and 900ft. above the level of the sea, and two stream gauges were erected, one on the southern branch of the river, which received the drainage of 2,076 acres, and the other on the northern branch 1,329 acres. The stream gauges were rectangular notches with sharp edges, such as were used by Mr. Francis, at Lowell, and the formula for calculating the discharge was that deduced from those well-known experiments. The observations were nearly eight hundred in number, and were recorded in an appendix. From a summary of the results it appeared that the rainfall for the year was 35·687in., or nearly 18 per cent. above that at Belfast. For the six months from November to May the rain was 14·766in., producing a flow of 14·351in., while from May to November these quantities were 21·101in. and 7·357in. The minimum flow off 1,000 acres occurred in August, and amounted to 11 cubic feet per minute; the maximum, in September, to 3,180 cubic feet per minute; and the mean monthly flow was at its minimum in July, and was 29 cubic feet per minute.

The particulars of one year's rain having been thus ascertained, it was assumed that the rainfall on the Carrickfergus mountains bore a constant ratio to that at Queen's College, Belfast, where a daily register had been kept for fourteen years, and that it was the greater by 16 per cent. The results then arrived at were, that the maximum rainfall in 1852 was 47·71in., the mean for the fourteen years 1851-64 was 38·42in, the average of the three dry years 1855-6-7 was 32·76in., and the minimum in 1855 was 28·8in.

The question then remained, how much of this rainfall was available for water supply. Twenty or thirty years ago the evaporation was taken as proportional to the rainfall, and was variously estimated at one-sixth, one-third, and two-thirds of the mean annual rain, according to circumstances. Now, the balance of opinion seemed to be that the amount of evaporation was not proportional to the rainfall; that it was either constant, or within narrow limits, where there was an identity, or similarity, in the physical features of the districts compared; that it varied under different circumstances in this kingdom from 9in. to 19in.; and that its amount in any particular case must be left to the experience and judgment of the engineer.

The author calculated that the loss, or the difference between the rainfall and the supply, which was the resultant fact of greatest importance to the engineer, varied in the Woodburn district 11·79in. to 15·16., the mean annual loss being 13·71in. The supply ranged from 14·57in. to 35·37in., the mean annual supply being 24·71in. The years of maximum and minimum supply were also the years of maximum and minimum winter rain. In the years 1856 and 1857, in which the rainfall only differed by 0·41in., the difference in the loss was 3·22in., arising from the fact of there being a winter rainfall of 15·96in. in the former, and of 22·03in. in the latter year.

The particulars were then given of the storage required for all quantities from the mean and annual supply down to that of the minimum year, from which it appeared that to store the whole rain yielded by the Woodburn district, 24·71in., a reservoir capable of containing 431 days' supply would be necessary; for the average of the three dry years, 18·28in., 132 days' would be required; while for the minimum, 14·57in., 119 days' would be sufficient. Diagrams were added showing the storage worked out for each month of the fourteen years, and for quantities of 24·72in., 20in., and 18in., and showing the state of the reservoir for a supply of 24in. for eleven years, and 20in. for the three dry years. It was remarked that, although the water in store attained its minimum in different years, that minimum invariably occurred in the month of October; and that as regarded the economical supply of water from the district under consideration, it would not be prudent to attempt to store a greater quantity of rain than about 10 per cent. over the average supply of three dry years, provided the extent of the gathering grounds could be increased.

The question of water power was then incidentally alluded to; and it was remarked that in dealing with useless and injurious floods, and in providing a town supply, care should be taken not to induce the destruction, by instalments, of the whole water power of the country, and injuriously to interfere with the natural regime of rivers. The proportion of the mean annual flow of both branches of the Woodburn River, from a rain basin of 4,750 acres, applicable to the supply of Woodlawn Mills, was then determined, and the calculations and results were given in detail. The tables showed that of the total flow off the ground, 21·71in., there was lost on Sundays and by floods 12·22in., leaving 9·49in., or nearly 44 per cent., available for the supply of the wheel, which was equivalent to 194 days full work during the year, or 1·78 times the mean flow of the stream. If the capacity of the wheel were reduced to 1·5 of the flow, it would work for 213 days, if to 1·25 of the flow for 218 days, and if just equal to the flow, it would work 243 days.

"ON THE WATER SUPPLY OF THE CITY OF PARIS,"

By Mr. G. R. Burnell, M. Inst. C.E.

This communication was principally confined to the methods adopted for securing the quantity of water required, and for its distribution and delivery; and was founded upon information obtained from M. Belgrand, the engineer-in-chief, as well as from numerous official documents.

It appeared that when this subject was first seriously entertained by the municipality of the enlarged city, in the year 1860, the population of Paris amounted to upwards of 1,600,000, and the quantity of water available from various sources was only 32,563,028 gallons per day, or rather more than 20 gallons per head per diem; but a large portion of this was used for municipal purposes, and nearly the whole of it was objectionable in quality. A careful study of the Paris basin, with a view to ascertain its capacity for furnishing a water supply, as dependent upon the geological conditions of the district and upon its meteorology, that had been carried on since the year 1844, showed that the basin of the Seine was formed of a part of the granite eruption of the Morvan, succeeded by the Jurassic deposits, without the intervention of the old and new red sandstones, or any trace of the carboniferous formation; the Jurassic deposits being in their turn followed by the cretaceous formations, and the whole being covered with the tertiary strata around Paris itself. It was remarked that French engineers and chemists attached great importance to the presence of the bi-carbonate of lime in water for drinking purposes; and that they held that a proportion of that salt, about sufficient to produce 16° of Dr. Clark's scale of hardness, was positively beneficial. Accordingly, in selecting the source, M. Belgrand gave the preference to the waters that filtered through the calcareous formations that outcropped around the granite. The waters of the Dhuis and of the Surmellin were brought to Paris, from the plains of Champagne, by an aqueduct, along which they flowed by gravitation, reaching the city at a somewhat higher level than had been calculated upon. The authorities had also purchased the right to take a considerable quantity of water from the River Marne, at St. Maur, above its junction with the Seine; while the waters of the Somme Soude had been at present passed over, and were left for the future extension of the works.

The springs of the Dhuis had yielded, in the driest season of the last twenty-one years, 6,698,400 gallons per day, and these of the Surmellin from 450,000 to 670,000 gallons per day. It was, however, believed that, by a series of operations connected with the drainage of the head lands surrounding these springs, the quantity from both these sources might be increased to 9,000,000 gallons per day, even during periods of prolonged drought. These streams after being united were led to Paris, in an aqueduct of masonry, that was never less than 4ft. 6in. high, and was at times increased to 5ft. It was carried on arches in those positions where the depression of the valleys did not exceed 33ft., and where greater, a cast-iron syphon, 3ft. 4in. or 3ft. 8in. internal diameter, was substituted. The section of the aqueduct was in general ovoidal, but in places the sides had a curvilinear batter, according to the nature of the strata traversed. Its inclination was as a rule $\frac{1}{10000}$, but that of the syphons was $\frac{55}{10000}$ in order to

accelerate the discharge through them. It was calculated to deliver 9,810,476 gallons per day, when running to within 1ft. of the crown of the arch, into the reservoirs lately built at Menilmontant, at a height of 301ft. above the level of the Seine. The materials employed in the execution of the masonry were *pierre meulière* set in the cement of Vassy; the whole of the interior and of the outside of the arches being "rendered," to avoid interference with the flow from the roughness of the surface, and to prevent the infiltration of the land waters.

The quantity of water obtained from the River Marne, at St. Maur, was about 9,000,000 gallons per day, when all the water wheels were at work. This was pumped into a second story of the reservoir of Menilmontant, at a height of 287ft. 7in. above the Seine. This water was tolerably pure and limpid, but it was rather hard, containing a considerable proportion of bicarbonate of lime, in conjunction with a sensible quantity of the carbonate of magnesia.

From the several sources which had been described, it was believed that a supply of 15 million gallons per day would be obtained in the course of this year, or, together with the existing supply, a total of upwards of 47 million gallons per day for a population of 1,667,841.

On the left bank of the Seine there had recently been purchased a series of springs rising from the chalk formation, at Armentières, in the valley of the Vanne, and their volume would be increased by the springs of Chigy, St. Philbert, Malhortie, Theil, Noe, &c. These waters would be led to Paris by an aqueduct 104 miles in length, and it was calculated that the quantity that would be so delivered would be equal to 22,328,000 gallons per day. When all the works for improving the water supply were completed, including the supply derived from the Marne, the Canal de l'Ourc and its increase, the Artesian wells about to be sunk in various parts of the city, &c., it was estimated that there would be a gross total of 105,388,160 gallons per day, a quantity more than ample for a much larger population than that of Paris was likely to become. But it must be borne in mind that the waters of the Canal de l'Ourc would still constitute more than one-half of the whole quantity, and, as this canal was navigable, it was exposed to various sources of impurity. In future two sets of pipes were to be established, one to supply spring water from the Dhuis, the Marne, and the Vanne, the other to supply the waters of the Ourc and the Seine for the service of the street washing, for the monumental fountains, and for other purposes of the municipality. The water now taken from the Seine was distributed with all the impurities it might contract during either seasons of flood or of drought. An inconsiderable quantity was filtered, in the interior of the town, at the *fontaines marchandes*, but the revenue derived from this was equal to about one-seventh of the total sum received for the sale of water in the course of last year.

Fourteen reservoirs were at present in use, of which four were reserved for the waters of the Ourc, nine for those of the Seine, and one for those of the aqueduct of Arcueil. Of these the last and two which now distributed the waters of the Seine were to be abandoned on the completion of the new works. The reservoirs at Menilmontant and at the telegraph of Belleville, lately constructed, were intended to receive the waters of the Dhuis and of the Marne, and they were calculated to contain together, in the two stories of arches of which they were composed, about 29½ million gallons. The cubical contents of the existing reservoirs, without including that of the Basin de la Villette, at the extremity of the Canal de l'Ourc, amounted to nearly 23 million gallons. A description was then given of the reservoirs of Passy and Menilmontant, and with regard to the former it was remarked that all the skill and attention of the French engineers had been employed in vain, in the attempt to prevent the action of atmospheric causes upon the masonry, which had given serious grounds for uneasiness, owing to the contraction and expansion of the masonry. It might be that the perfection of the setting of the cement upon the masonry had something to do with this effect, for it could not yield, like an elastic substance, such as mortar of the proper quality of hydraulic lime. In the construction of the reservoir at Menilmontant, the surface of the excavation in the gypseous marls, which were hard when originally cut, but which yielded under the influence of the atmosphere had been "rendered" with a coating of plaster of Paris 1½in. or 2in. in thickness. This had been found to be an efficient temporary protection from disintegration, under the effects of rain and of frosts.

The appliances for securing the effectual distribution of the water brought into Paris, and the quantities required for the different services, were then detailed; and it was stated that the authorities undertook to deliver, when all the works were completed, gratuitously to the citizens a total quantity of 54 million gallons per day. The execution of the works required for the distribution of the water to private houses and factories has been undertaken by a company, under an agreement with the town, for fifty years, during which time it was to collect the water rates, and at the expiration of that period, the whole of the estate was to become the property of the city. The profit arising from the execution of these works, at a fixed schedule of prices, and a sum agreed upon as a remuneration for the risk and trouble undertaken by the company, were the first charges upon the revenue, and the excess beyond these amounts was shared in the proportion of 75 per cent. to the town, and 25 per cent. to the company. In this way it had been estimated, by M. Belgrand, that during the year 1863, 17 million gallons of water had been delivered. The receipts for the private supply in 1864 amounted to 3,822,760 francs from 23,074 subscribers, a number which, it was calculated, would be increased by 2,000 in twelve months. Considering that there were upwards of fifty thousand houses in Paris, this might be cited as a proof, if such were wanting, of the bad effects that must always attend the gratuitous supply of water upon the habits of daily life of the citizens. It might be added, that the price charged to the water-carriers at the filtering fountains was nine pence for 230 gallons, and this quantity was retailed for four shillings. This increase in the price was one of the principal reasons brought forward to justify the great outlay incurred in leading to Paris the spring water from the Dhuis and the Vanne.

In conclusion, the author thought, upon a review of all the conditions of the Paris water supply, that it must be regarded as a commercial failure; for while the town paid 2,060,000 francs for salaries and repairs, it derived only 4,750,000 francs from every source of revenue, including interest and sinking fund. It might, however, fairly admit of doubt, whether the system had been a failure, if considered as a means of meeting the wants of the inhabitants, who were themselves too poor to pay the rates that would be required to defray the expense of conducting the water to their houses. But the system was believed to be wrong, inasmuch as it entailed upon the city a heavy burthen for the water supply, which no one had a direct interest in checking, because it was paid for out of the town dues, instead of being made a separate charge upon the funds of the city.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last ordinary monthly meeting of the Executive Committee of this Association was held at the offices, 41, Corporation-street, Manchester, on Tuesday, April 24th, William Fairbairn, Esq., C.E., F.R.S., LL.D., &c., in the chair, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

During the last month 197 engines have been examined, and 305 boilers, as well as four of the latter tested by hydraulic pressure. Of the boiler examinations, 201 have been external, 6 internal, and 98 entire. In the boilers examined, 61 defects have been discovered, 2 of those being dangerous.

Tabular Statement of Defects, Omissions, &c., met with in the Boilers Examined, from March 24th, 1866, to April 20th, 1866, inclusive.

Description.	Number of Cases met with.		
	Dangerous.	Ordinary.	Total.
Defects in Boiler.			
Furnaces out of Shape	...	4	4
Fracture	1	9	10
Blistered Plates	...	3	3
Corrosion—Internal	...	12	12
Ditto External	...	7	7
Grooving—Internal	...	4	4
Ditto External	...	1	1
Total Number of Defects in Boiler	1	40	41
Defective Fittings.			
Feed Apparatus out of order	...	1	1
Water Gauges ditto	...	1	1
Blow Out Apparatus ditto	1	3	4
Fusible Plugs ditto	...	1	1
Safety Valves ditto	...	1	1
Pressure Gauges ditto	...	3	3
Total Number of Defective Fittings	1	10	11
Omissions.			
Boilers without Glass Water Gauges	...	...	...
Ditto Safety Valves	...	...	...
Ditto Pressure Gauges	...	...	...
Ditto Blow Out Apparatus	...	...	...
Ditto Feed back pressure valves	...	8	8
Total Number of Omissions	...	8	8
Cases of Over Pressure	...	...	...
Cases of Deficiency of Water	...	1	1
Gross Total	2	59	61

Four explosions have occurred during the past month, by which eight persons have been killed and twelve others wounded; while a fifth explosion, which occurred on February 26th, has now to be recorded, since it was not reported in time for the last monthly table. It will rank as No. 10a. Not one of the boilers in question was under the inspection of the Association. The following is a tabular statement:—

Tabular Statement of Explosions, from March 24th, 1866, to April 20th, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
16	Mar. 27	Ordinary Double-flue, or "Lancashire." Internally-fired	2	6	8
17	April 4	Single-flue, or "Cornish." Internally-fired	5	5	10
18	April 10	Plain Cylindrical, egg-ended. Externally-fired	1	0	1
19	April 16	Small Portable. For working Crane	0	1	1
		Total	8	12	20

No. 14 Explosion was recorded in last month's table, but full particulars were not received in time for the report. These may now be given. This explosion, which resulted in the death of one man and injury to a second, as well as in considerable destruction of property, took place at eleven o'clock on the morning of Tuesday, March 13th, at a brewery, to a boiler not under the charge of this Association.

The boiler, which was externally-fired, was cylindrical, with flat ends, having two flue tubes running through it from end to end. Its size was very small, its length being only about 8ft., its diameter in the shell 3ft. 3in., and in the flue tubes 8in., the thickness of the plates being $\frac{3}{8}$in. in the cylindrical portion of the shell, $\frac{7}{16}$in. in the flat ends, $\frac{5}{16}$in. in the flue tubes, and the pressure of steam about 45lbs. on the square inch.

The cause of the explosion was reported to be clearly attributable to the neglect of the stoker, who had been killed thereby. "He had," it was said, "allowed the water to get too low in the boiler; and then, instead of drawing the fire and letting off the steam, had admitted cold water upon the hot plates, in consequence of which the boiler was instantly rent in pieces, the surrounding walls and the roof thrown down, the engine buried in the ruins, and the unfortunate man blown into an adjacent beck, amid boiling liquor; while, it was added, with due editorial authority, in conclusion, that the stoker had been clearly in fault, and it was hoped the explosion would be a warning to men attending to steam boilers and engines.

It appears to be an inveterate custom to attribute every explosion to the neglect of the fireman, and generally to his allowing the supply of water to run short. and more particularly so when it happens, as it too frequently does, that the poor man has been killed by the explosion. Firemen, however, are more frequently the victims than the cause of explosions, which was the case in the present instance, and will be seen from the following:—

"The manhole was placed lengthwise on the top of the boiler, and unguarded with any strengthening ring or mouthpiece whatever. The cover was one of the old-fashioned internal sort, which are kept up to their work partly by the pressure of the steam, and partly by one or two bolts and nuts suspended from bridges. The action of these internal covers, especially when not a good fit, is to strain the shell of the boiler very severely, the pressure of the steam, aided by the pull upon the bolts, tending to drive the cover completely through the manhole and to burst it open. This was precisely what took place in the present instance. The manhole was burst open by the cover in the first instance, and a rent being thus started, the pressure of steam instantly ripped the boiler open from one end to the other, through the line of fittings on the top, the plates being also torn away from the angle irons by which they were attached to the ends, and opened out almost flat. The principal force of the explosion expended itself upwards, which is readily explained by the position of the rent; while the manhole cover was blown to a distance estimated at upwards of 100 yards, although the body of the boiler remained near to its original position.

"The danger of these unguarded manholes has frequently been pointed out in the Association's report, and several explosions due to this cause recorded. These may be thus enumerated:—One, No. 2 Explosion, 1863, February 6th; a second, No. 3 Explosion, 1865, January 9th; a third, No. 5 Explosion, 1865, February 6th; a fourth, No. 43 Explosion, 1865, December 12th; while full particulars of each of these were given in the monthly reports for February, 1863, January, 1865, November, 1865, and December, 1865, respectively.

"A scientific witness, who at the request of the coroner gave evidence at the inquest, clearly pointed out the weakness in the construction of the boiler, consequent on the unguarded manhole, and attributed the explosion to that cause, in accordance with the views just expressed; while, however, the engineer, who was in the habit of repairing the boiler when necessary, and whose duty it was to examine it and report to the owners of any defects, considered that the boiler was perfectly safe, having examined it but a few days before it burst, and thought the explosion was a pure accident, referable to no ascertainable cause.

"Since such vague views are entertained on this subject by those who have charge of boilers and consider themselves practical men, and as many as five explosions within a little more than the last two years can be referred to the weakness of unguarded manholes, it is surely not unnecessary to repeat the recommendation already so frequently given, viz.:—That every manhole should be strengthened with a suitable mouthpiece.

"No. 16 Explosion, by which two persons were killed, and six others injured, occurred at half-past eight o'clock on the morning of Tuesday, March 27th, at a woollen rag and mungo works.

"The boiler which was not under the charge of this Association, was of the ordinary double flued class, so commonly used at the mills in this district. Its length was 24ft. 6in., its diameter in the shell 6ft. 6in., and in the flues 2ft. 6in., the thickness of the plates being $\frac{3}{8}$in bare in the cylindrical portion of the shell, as well as in the flue tubes, and $\frac{1}{2}$in. in the flat ends, while the load upon the safety valve was about 60lbs on the square inch. The boiler was set on 'side walls,' the course of the flame, immediately after leaving the internal flue tubes, returning along each side of the boiler, and finally passing under the bottom towards the chimney.

"The boiler gave way in the cylindrical portion of the shell, the primary rent occurring in the last ring of plates at the back end, and in the right hand flue. This rent ran longitudinally for about 3ft., which was the entire width of the plate, and close to a seam of rivets situated just at the edge of one of the 'side walls' on which the boiler was seated. From this primary longitudinal rent two others started in a transverse direction, one from each end, the first of these running round the entire circumference of the boiler, through the line of rivet holes at the angle iron attaching the shell to the end plate, and the second also completing the circle of the boiler within a few inches, and in a direction generally parallel with the first, so that a complete belt, varying from three to about 4ft. or 5ft. in width, was ripped from the shell, and left hanging to it by only a little piece of plate. The flat end also was folded back, while the furnace tubes and the remainder of the shell were unaffected. On the occurrence of these rents the boiler was thrown from its seat and driven into the firing space for a length of about 12ft., where its course was arrested by the end wall of an adjoining building. Its brickwork seating was completely broken up, and the entire works laid in ruins, the roofs and floors falling on the workpeople, and thus adding materially to the injury which resulted from the rush of steam and hot water from the ruptured boiler.

"There can be no doubt as to the cause of this explosion. The plate in the vicinity of the primary longitudinal rent, already referred to, was deeply and extensively corroded on its external surface, and so eaten away thereby, as to be reduced to about $\frac{1}{16}$in. in thickness. This corrosion appeared to be due to leakage of the seams, the water from which trickled over the plates, and ponded in the brickwork seating. This was corroborated by the evidence of the man who had swept the flues once a month for the last three months. He stated that he had on each occasion discovered leakages in that part of the boiler near to where the primary rent occurred, and had been wetted by the water which came from them. There is the greater danger of this corrosion taking place in those cases where the seatings are wide, and the bottom of the side flues is flat, so that the soot lies right against the plates, and any water that gets into the flues moistens the soot, and soaking into the seating lies against the plates. There appears to be every reason to conclude that this mode of setting was adopted in the present instance, but the brickwork had been so thoroughly shaken that it was very difficult to arrive at minute details with certainty. It will be clear, however, that leakages or moisture in any shape must be doubly dangerous to boilers set in the objectionable manner just described, and which is called attention to on the present occasion, since too many members of the Association have allowed their boilers to be set in this way, and do not appear to be alive to its danger; whereas, all boilers set upon 'side walls' should be mounted upon fire brick blocks, so as to leave a pocket at the bottom of the flues for a subsidence of soot and moisture.*

"The injury to the plates of this boiler must have been going on for some time. When water is of a very corrosive tendency plates may be eaten through in less than two years, but this is unusual; and inasmuch as it did not appear that the water was of a peculiar character, in the present instance there is every reason to conclude that the corrosion had been going on for some three or four years. It will, therefore, be perfectly clear that faithful periodical inspection could not have failed to detect the corrosion in time to prevent the explosion, while even this might have been done had a competent flue examination been made as much as two years ago.

"The Jury brought in a verdict of 'accidental death,' at the same time expressing their opinion that the explosion had occurred from corrosion, and would have been prevented by a proper examination of the boiler, adding that such examinations should be periodical and made at least once a year.

"No. 18 Explosion, by which one man was killed, occurred at six o'clock on the morning of Tuesday, April 10th, to a colliery boiler not under the charge of this Association, and which was of the plain cylindrical, egg-ended, externally-fired class, 34ft. long, 5ft. in diameter, and made of plates $\frac{3}{8}$in. in thickness; the ordinary working pressure being about 35lb. on the square inch.

"The boiler was comparatively new, being but about four years old. It had undergone slight repairs only a few days previous to its explosion, and was considered to be perfectly safe. The engineman had but just tested the safety-valves on the top of the boiler, and found them to blow off all right, when the

* A detailed description of the plan of setting boilers on 'side-walls,' recommended by the Association, with a drawing showing the proportions and dimensions of the flues and seating blocks, was given in the monthly report for August, 1863, forwarded to the members. This report is now out of print, but a drawing lies at these offices which is open to the inspection of the members, a consultation of which may prove of service to those resetting their boilers.

boiler burst, rending at one of the circular seams over the fire. There was plenty of water in the boiler at the time, and the plates exhibited no signs of corrosion.

"This is only another of those explosions which so constantly occur to these plain cylindrical egg-ended externally-fired boilers, and it will be found on reference to the monthly reports which the Association has published, giving particulars of explosions as they have occurred from time to time, that in 1863 fifteen externally-fired boilers exploded, killing eighteen persons and injuring twenty-three others; in 1864, eleven externally-fired boilers exploded, killing forty persons and injuring thirty-five others; in 1865, thirteen externally-fired boilers exploded, killing seven persons and injuring twenty-one others, making a total for three years of thirty-nine explosions to this class of boiler, resulting in the death of sixty-five persons, and in injury to seventeen-nine others. It is trusted that these facts, and the continued record of fatal explosions as they occur month by month, will at length convince steam users of the danger of these plain cylindrical egg-ended externally-fired boilers.

"There is yet an interesting fact with regard to the three explosions just reported which should not be passed over in silence. The three boilers had all been insured by a Boiler Insurance Company although, fortunately for the company, only one of the policies remained in force at the time of explosion, the other two having lapsed a short time previously. This, however, had been the act of the boiler owners, and not of the Insurance company, who were willing to renew the policies. It will be remembered that the first of these explosions arose from the weakness of the boiler at the unguarded manhole, and the second from wasting of the plates through corrosion, which would have been detected in time to prevent the explosion by a faithful flue examination, whereas no flue examination had been made during the whole of the four years the boiler was Insured; while the third was due to the failure of one of the ring seams in a boiler of the dangerous plain cylindrical externally-fired class.

"The occurrence of these three explosions, resulting in the death of four persons and injury to seven others, as well as in considerable damage to property, will, it is thought, reopen a question already frequently asked, viz.:—Whether the application of insurance to boilers by commercial and competing companies is sound in principle and the best that could be adopted for the Prevention of Explosions? It is very generally supposed that a commercial company insuring boilers for the sake of dividends would inspect them for its own interests. This, however, is quite a mistake. Inspection is expensive. Insurance is cheap. Inspection, it has been found by the experience of the Association since its formation twelve years ago, costs upwards of 20s. per boiler per annum, while insurances could be effected, without any inspection at all, for about 2s. per cent. Internal and flue examinations, therefore, can only be enforced at the expense of profits, and a commercial company, with a proprietary looking for dividends, will clearly not expend 20s. to save 2s., but prefer to trade in insurances rather than inspections. In the event of explosion, insurance affords a poor compensation even for the loss of property, to say nothing of the loss of human life. The receipt of £100 or £200, according to the amount of policy, is generally quite inadequate to cover the loss. In one case referred to above, the whole works were laid in ruins; and in another, I am informed, £1,000 would not cover the damage done, although the insurance upon the boiler only amounted to £100. Insurance, therefore, affords the owner but meagre compensation for the loss of his property, and the workpeople none whatever for the loss of their lives. What the steam user needs for the security of his property, and the poor firemen and workpeople engaged near to boilers for the security of their lives, is inspection, not Insurance; Prevention, not compensation.

PETROLEUM AS FUEL.

The question of the use of petroleum for heating purposes has of late so amply engrossed the attention of engineers, both on this and the other side of the Atlantic, that we have no doubt the following report of a trial that took place at New York, at the end of last year, will be welcome to our readers. The trial was conducted by Mr. J. A. Adams, the engineer to the Petroleum Light Company, 207, Pearl-street, N.Y., who hold the patents for petroleum heating, taken out in the United States and in Great Britain by Mr. Simon Stevens. Mr. Adams says:—

The difficulty hitherto has been in attempting to burn the crude petroleum, that the imperfect combustion alone attainable by the means in use has resulted in great waste of the material, as shown by the dense smoke which invariably accompanied all attempts to burn it in a confined space This, and the difficulty of regulating the feed, have hitherto prevented a successful application of this material as a fuel in the generation of steam in boilers. I am well aware that it has occasionally been accomplished on a small scale, but no experiments that I have knowledge of have exhibited anything like the requisite command of the material in feeding the fire, or certainty in its use as a fuel. This remark is made in full knowledge of what has been accomplished in this direction by Messrs. Linton and Shaw, as well as by Mr. Richardson in England. This difficulty has, I think, been successfully overcome in the experiments conducted for your Company, and the crude petroleum, without other fuel than the chips for kindling the fires, has been burnt daily under a marine boiler, in a course of experiments extending from the month of May last, and proves more manageable, more under the control of the fireman, and develops an amount of heat greater than any fuel with which we are acquainted.

Mr. George W. Quintard, of the Morgan Iron Works, having offered us the use of marine boiler for our experiments, we applied our apparatus to it, without regard to any disproportion which might exist between the two, further experiments being needed in order to determine their precise relative dimensions. The experiments thus far have not extended beyond the determination of the fact that petroleum may be used with great facility as a fuel under steam boilers, by a single fireman of ordinary intelligence. No minute analysis has been made of its comparative economy, the results thus far being regarded as merely general; but from the results herewith shown, you will be enabled to determine how far our experiments sustain the claim we have advanced of having successfully applied this material to steam boilers.

The boiler used was an internal flue and return fire tube boiler, the shell measuring 13ft. 9in. in length, by 6ft. in diameter, with a grate surface of 35 square feet.; contents, about 1,500 gallons of water to the level 6in. above the upper line of tubes. There were three flues in the boiler, the centre one, *P*, of 16in. diameter, and the other two, *R*, of 12in. diameter. The boiler was not set as represented in figs. 1, 2, and 3, which is the method recommended, but rested merely on three walls of the dimensions of the furnace walls. There were five rows of $2\frac{1}{2}$in. fire tubes, as shown in fig. 3, being 75 tubes in all, the back connection being 15in. by 3ft. 5in., and the smoke stack 30in. in diameter. The boiler was unclothed. Fig. 1 is a cross section of the boiler through the furnace, and fig. 2 is a longitudinal section through the centre of the boiler and furnace. Fig. 3 represents the plan of the furnace, showing the arrangements of the retort or mixer, and the oil and steam tubes. The same letters refer to the same parts in the several figures.

The fire bars were removed, and in their place a coil of $\frac{3}{4}$in. wrought iron pipe *A* was inserted, the total length of coil in the pipe being 23ft. At the back, directly across the furnace, a wrought iron tube *B*, or retort, 5in. in diameter, and closed at both ends, was placed, with a short tube *C*, of 2in. diameter immediately in front of it. Into this latter tube (which communicates with the retort) one end of the coil is inserted, and the other end *D*, passing out of the furnace door, communicates with the reservoir of oil, being in this case the cask in which it was brought to market. The flow of oil is regulated by a stop-cock, *M*, placed near the furnace door. Some 8in. under the coil of pipe lie ten 1in. wrought iron tubes, *N*, closed at one end, the other end inserted into the retort; these tubes lie parallel to each other, and are 2ft. 3in. in length, and into each of them are tapped nine cast iron burners, *F*, with $\frac{1}{16}$in. opening, making in all ninety burners. An inch above the plane of the coil, a wrought iron pipe, *G*, proceeds direct from the short tube in front of the retort into which the coil is inserted, to the furnace door, and thence to the steam space of a small auxiliary boiler; a branch, with proper valves, *K*, connects this pipe with the steam space of the main boiler—the flow of steam being also regulated by a stop-cock, *H*, placed in the vicinity of the furnace door, near the oil cock.

The water in the boiler being cold (sixty degrees), at 2.15 p.m., some billets of pine wood and shavings, weighing 12lbs., being placed upon the coil, near the furnace door, were lighted and the door partially closed; after an interval of fifteen minutes the oil cock, *M*, was gradually opened, which permitted a flow of oil from the reservoir through the coil; simultaneous with which, or a little later, the steam cock, *H*, was opened, which conveyed steam of 20lbs. pressure from the auxiliary boiler, through the heated steam pipe, *G*, above the coil, to the retort or mixer, *E*, where combining with the vapour of oil from the coil, it passed into the straight pipes, *N*, under the coil, and was fired at the burners, *F*. The flame was vivid and intense, regulated in its force by the relative flow of oil and steam, and was entirely under the control of the fireman, who, at his pleasure, could reduce the flame to the flicker of an expiring lamp, or extend it by a single movement to a volume filling the large flues and furnace with its flame. No smoke or unpleasant smell was perceptible, and the combustion was complete and entirely manageable. Steam, at atmospheric pressure, was raised in the boiler twenty-nine minutes from the time of admission of oil into the coil. No measure was taken in this experiment of the amount of water evaporated; the apparatus not being considered as properly proportioned to exhibit the economical value of the fuel, and the experiment terminated in about one hour by closing the oil-cock, *M*—and the fire was out.

The analysis of this experiment may be shown as follows. As this experiment only exhibited the weight of oil which, consumed under the boiler, raised a given quantity of water from a temperature of 60° to the boiling point, it is requisite for a comparison with the known effects of anthracite coal, to show the proportionate amount of oil which would be necessary to convert this same bulk of water into steam of the atmospheric pressure, or the weight of water which 1lb. of this fuel will convert into steam.

According to Tredgold, the quantity of fuel which will convert a cubic foot of water, of a given temperature, into steam, at the pressure of the atmosphere, is obtained by multiplying the quantity of fuel which will heat a cubic foot of water one degree, by the sum of the latent heat of steam, and the difference between 212° and the given temperature of the water. In this case, $212° - 60° = 152°$. The latent heat of steam,

according to Dr. Ure, is 967° which, added to 152° = 1,119°, which multiplied by the quantity of fuel which will heat a cubic foot of water one degree, will give the weight of fuel requisite to convert a cubic foot of water from the temperature of 60° into steam. This product multiplied by the number of cubic feet of water to be converted into steam, will give the total amount of fuel required in this case.

Making the proper allowance for the pine wood in lighting the fires, the weight of oil consumed in the experiment was 60lbs.; the contents of the boiler were 200 cubic feet at a temperature of 60°, which were heated by this weight of oil to the boiling point = 212°; thus the weight of oil which heated 200 cubic feet one degree was $\frac{60\text{lbs.}}{152} = 0.39$lbs.; and the weight of oil which was requisite to heat one cubic foot of water one degree was $\frac{.39}{200} = .0019$lbs. This multiplied by 1,119° = 2.126, and this by the 200 cubic feet of water in the boiler gives 425lbs. as the weight of oil which would convert the contents of the boiler into steam at the atmospheric pressure — or $\frac{200 \times 62.34}{425} = 29.33$lbs. as the weight of water at a temperature of 60°, which will be converted into steam by one pound of oil. From Isherwood's valuable experiment on marine boilers, we find the same type of boiler in use on board of the U.S. steamers—and from the mean of the experiments conducted on these boilers, we find the quantity of water evaporated from a temperature of 100° with steam at the pressure of the atmosphere by 1lb. of anthracite coal, to be 8.5lbs. To compare this with the evaporation made from a lower temperature of water by means of the oil, this weight must be reduced in the following ratio, established by Isherwood:—

$$\frac{966+112^\circ}{966+152^\circ} = \frac{1073}{1118} = 0.964$$

which multiplied by 8.5, gives 8.16 as the weight of water at 60°, converted into steam of atmospheric pressure by 1lb. of anthracite coal.

Comparing this result with that above shown for the product of the combustion of oil, we find the evaporating power of the two fuels to be in favour of the oil, in the ratio of 29·33 to 8·16, or 3·6, weight for weight, the coal and the oil occupying about the same space for a given weight; that is to say, a cubic foot of coal as stowed aboard ship will weigh about the same, or a little less, than a cubic foot of oil, the first weighing from 43lbs. to 52lbs., and the latter about 54lbs. to the cubic foot.

Further experiments, with improved apparatus, will be necessary in order to determine the precise economic value of this fuel in comparison with coal, but the advantages of the oil as a fuel for marine engines may be briefly summed up, as follows:—

Rapidity with which steam may be raised—reduced dimensions of boiler and furnace below that required for coal—the continuous firing effected by feeding the fuel through a pipe into the furnace, thereby preventing the great loss of heat in the furnace every time a fresh supply of coal is thrown on, and the rush of cold air upon the opening of the furnace doors—the freedom from smoke, cinder, ash, or refuse of any kind, which in coal reaches from 7 to over 16 per cent. of the whole amount. In the ability to command a forced fire almost instantly, without a forced draught, which, under some circumstances at sea, is of vital importance. In dispensing with the numerous class of coalheavers, stokers, &c., and all the inconvenience of raising clinkers and ash from the furnace rooms, and, finally, the diminished space occupied in the storage of the fuel.

FIG. 1.

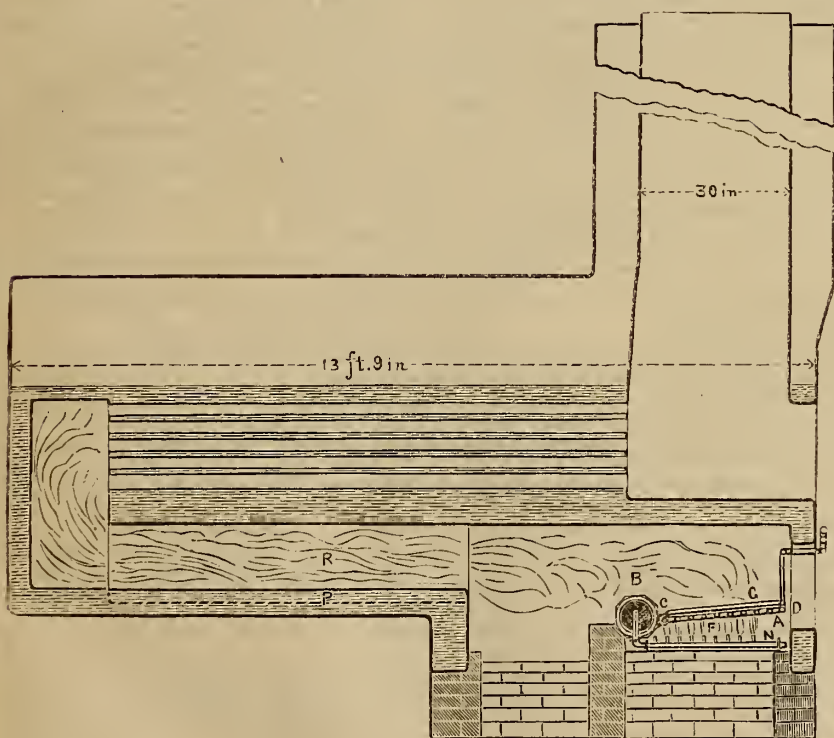


FIG. 2.

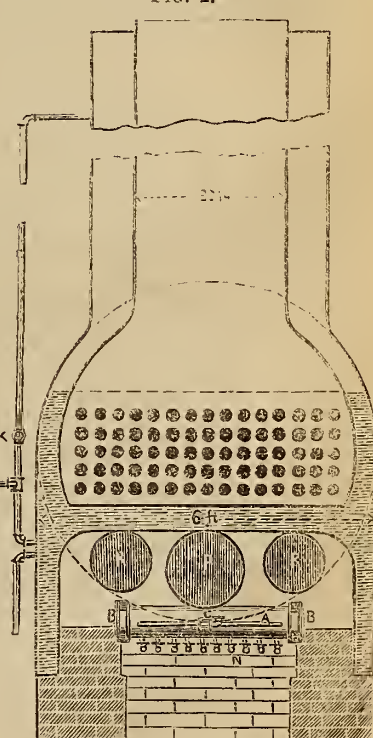
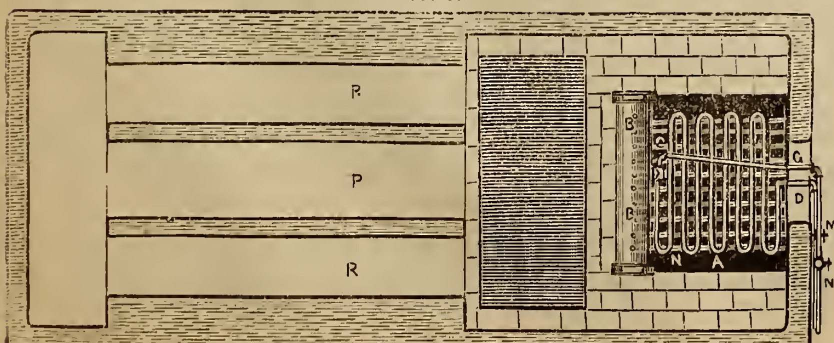


FIG. 3.



REFERENCES.

A. Coil of Pipe from the Oil Reservoir.
B. Retort or Mixer.
C. Short Connecting Pipe.
D. Pipe leading to Oil Reservoir.
F. Burners, 90 in number, 1-16th inch each.
G. Steam Pipe.
K. & H. Steam Valves.
M. Oil Valve.
N. Tubes into which are screwed the Burners.
P. Large Flue of Boiler.
R. R. Smaller Flues of Boiler.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The ordinary monthly meeting of members of this society took place on the evening of Saturday the 5th ult., Mr. Joseph Newton in the chair. After the routine business had been disposed of and sundry elections effected, Mr. Sanson re-opened an adjourned discussion on "The various modes of Smelting Iron." He must, he said, in the first instance, acknowledge that since the reading of the paper on this subject by Mr. Oubridge, two months ago, he had acquired an increased stock of information on furnaces, metals, and castings. Speaking, however, from an engineering point of view, he must admit that his mind had been a little confused by the somewhat conflicting evidence furnished by the various foremen of iron foundries who had previously spoken. It was difficult, indeed, to comprehend why one kind of furnace should succeed admirably with some and fail with others. Another feature which required some notiee was the statement made by the author of the paper to the effect that foremen moulders were hampered in their attempts to produce good castings by not being allowed to select the materials to be used. His (Mr. Sanson's) experience did not justify that assertion. He had always, on the contrary, observed that employers consulted their foremen as to the selection of the various kinds of iron requisite for producing castings for particular purposes, and at any rate it was clearly desirable that this should be the case. It was important that the engineer and the ironfounder should co-operate together, for each had his speciality, and the action of one without that of the other led to confusion and undue expenditure. Unless a combination of this kind were effected generally in English engineering establishments, or the art of moulding reached by some other means to a higher pitch of excellence than it had as yet attained, it would be found that other countries would excel us in the production of good castings. He alluded more particularly to the artistic character of castings. If we looked across the Continent even now we should see symptons of improvement in that direction which were not visible at home. This last statement was met with some marks of dissent, but Mr. Sanson reiterated it, and instanced some of the castings which were exhibited in the foreign department of the last Exhibition, and to which the palm of superiority had been awarded. Mr. J. Hosking remarked that, with respect to some of the new forms of furnace which had been mentioned, they certainly had been instrumental in diminishing the waste of the metal. Formerly 10 per cent. had been the minimum of waste, now 5 per cent. only was the average loss. This was due largely to improvements in the application of the blast and its more equal distribution in the furnace. He was convinced that the quality of the metal depended very much upon the same causes.

Mr. Stabler admitted that he had not had much experience in the casting of metals. He agreed with much of what Mr. Oubridge had advanced, and especially with that portion of his paper which referred to selections of iron being made for the founder's use by persons not qualified to judge of its peculiarities. He had known men to be employed in the purchase of such material who did not know Welsh pig from Carron pig. This certainly placed the founder at a great disadvantage. With regard to the quality and finish of English castings as compared with those of some other countries, there was much to be said. He believed that our own workmen excelled in the production of common and useful work of this description, while in the matter of merely ornamental castings those of France and Germany were far in advance. Many reasons might be adduced for this, one being in his (Mr. Stabler's) opinion the comparatively little aid which had been given at home by the engineer to the moulder. Very frequently the boxes made for the use of the latter were defective in construction. The amount of scientific assistance rendered to the founder was admittedly small. It was a fact that chemists did not possess a very accurate knowledge of the constituents of iron, and if that were so it was not surprising that the founder should also be at fault; no doubt there was room for improvements in English iron smelting and founding, but he did not think that in those arts we were far behind our continental neighbours as a whole.

Mr. Lawder recounted some of his own practical experiences in various iron foundries of London, and took a considerable amount of credit to himself for the economical changes he had effected therein. In the formation of good castings more depended on the foreman's practical knowledge in regard to the qualities of pig and scrap iron and fuel, than on the shape of the furnace or the application of the blast. He had himself melted, on one occasion, 18 tons of metal and 13 cwt. of coke.

Mr. Campbell, in reference to continental and British castings, had to say that, from the general lowness of wages abroad, more time was devoted to their production than could be afforded at home. Foreign workmen, in every branch of the engineering trade, were excessively slow in their movements, and were an English foreman called upon to superintend them, he would soon lose his patience. Probably, nay certainly, we should produce better castings of every kind than could be produced on the continent if the same amount of time was devoted to the work. He knew of some small foundries in the metropolis where beautiful castings were constantly produced, and which would stand the test of comparison with any that the world could furnish. Our founders had all the skill necessary for their duties; competition and other circumstances compelled them often to sacrifice quality to quantity.

Mr. Oubridge, in reply, maintained that a great deal depended on the furnace and its treatment in the creation of sound and clean castings in an economical way. He reiterated some of his previous statements as to the chemical changes which occur to the iron while in a state of fusion, and said that a furnace of 5ft. area should be made to melt four tons of metal with an expenditure of eight tons of coke per hour. He was sorry to complain of engineers, to some of whom, as a practical ironfounder, he must acknowledge himself indebted, but occasionally they did interfere somewhat unwarrantably, and presumed to advise on subjects which they did not thoroughly understand. He wished not to say this offensively. Few engineers understood moulding, and it would be well if they were to consult with those who did before completing their designs and making their patterns. By such an arrangement he did not hesitate to say a saving of 15 or 20 per cent. might often be effected in the prime cost of work to be done. Mr. Oubridge touched upon the coal exhaustion question next; he then spoke of the various brands of iron in general use, and finally referred to the foreign castings in the Exhibition of 1862. In doing so he adverted to a searching and critical examination, which, in company with their president and some thirty or forty other practical gentlemen, he had made of those castings, and stated that the unanimous conclusion arrived at by the party was that they were very inferior those found in the English department.

The chairman said it now became his pleasant duty to propose a cordial vote to Mr. Oubridge for the able manner in which he had introduced the subject of iron melting to their notice. He felt assured that if the members of the Association generally would follow the example of that gentleman and introduce successively such practical questions as they could each deal with, great advantage to all must be the result. The discussion, which had now concluded, he considered to have been instructive to the last degree, and although different opinions had been expressed they all tended to elicit information and to develop truth. The vote of thanks was then carried by acclamation. This compliment was briefly acknowledged, and after the chairman had announced a paper for the June meeting on "Hydraulic Engineering," by Mr. Hendry, the meeting ended.

BOILER EXPLOSIONS IN THE UNITED STATES.

From January to February 3, 1866.

Jan. 5.—Explosion of three bricks at Columbia Pa.; two men killed, three wounded. No cause known.

Jan. 9.—Locomotive on New Jersey Central Railway exploded; three men killed, two wounded. No cause assigned.

Jan. 19.—Boiler exploded in Baltimore; three men injured. No cause.

Jan. 29.—Boilers of Carhart and Needham's Melodeon Manufactory, Twenty-third-street, New York. Boiler overheated by sudden falling of water, flues expanded, forcing out heads and breaking many rivets.

Jan. 30.—Locomotive on Boston and Gowell Railway exploded while at rest; one killed, two wounded. No cause ascertained.

Jan. 30.—Terriffic explosion on Ohio river. Steamboat *Missouri* destroyed; one hundred killed. No cause determined.

Jan. 30.—Awful explosion of steamboat *Miami* sunk on Arkansas river; 225 killed. No cause known.

Jan. 31.—Locomotive on New Orleans and Jackson Railway exploded; three killed and four wounded. No cause ascertained.

Feb. 2.—Fearful explosion of steamboat *W. R. Carter* on Missouri river; 150 killed. No cause determined.

Feb. 3.—Steamboat *Baltic* exploded her boiler while leaving dock at New Orleans; three killed and seven wounded. No cause known.

Feb. 3.—Explosion of a boiler in a mill at Petersburg, Va.; six killed and seven wounded. No cause known.

This record shows that 491 persons were killed in less than one month. The number wounded in the three great cases is not given; in the other cases it was 38; probably there were many wounded in the three chief cases. Estimating the killed at the average price of negroes before the war, say 1,000 dolls. gold, equal to 1,400 dolls. currency, we have 687,400 dolls. worth of people killed, besides the damaged. Multiplying by 12, we should have at this rate 8,248,800 dolls. worth of killed in the year. Here is a margin for saving. To this we may add, for persons and property damaged, a large sum, which ought to be carefully estimated. If any humane person is shocked at this way of treating the matter, we hope he will excuse us on the ground that it is the only practical way to lead to any improvement.—*American Artizan.*

THE PAST AND PRESENT PRODUCTIVE POWER OF COTTON MACHINERY.

(*Continued from page* 113.)

PART I.—*Ancient History*.—(Continued).

Concerning the fineness of India fabrics, many surprising stories are told. The Emperor Aurungzebe, who flourished at the commencement of the last century, on perceiving his daughter arrayed in a semi-transparent tissue, reproached her with indecency; she defended herself by assuring him that her robe was wrapped nine times round her body. Travernier relates that a Persian ambassador, on his return from India, presented his king with a cocoa-nut which contained a muslin turban, thirty yards long, and which, when expanded in the air, could hardly be felt. Some of their broad webs of muslin may be drawn through a wedding ring. The following description of the very primitive methods of preparing, spinning, and weaving cotton amongst the Hindoos will be of service in comparing the ancient with the modern means of producing cotton cloths. After the cotton has been extracted from the pod, it is subjected to the action of the churka or roller gin, the object being to extract the seeds from the fibres in a quicker manner than by plucking them apart by the human fingers. Another method of clearing the seeds from the cotton was by means of the Hindoo bow, an instrument which is made of bamboo, and is fastened by strings to the wall of the room, at about five feet from the floor. To the middle of this bow a cord is tied, to which a second bow is attached, of a larger size, strung with thick catgut. This second bow hangs about two feet above the ground. The man sits down, lays hold of it with his left hand, and holds a strong ebony club in his right. Thus equipped, he strikes the string of the bow with his club, so as to make it toss a flock of the foul cotton spread upon the floor round about him, up into the air with great violence, and thus discharges its impurities. The coarser and stronger stapled cotton of Upland, Georgia, America, was originally cleaned by the vibrating stroke of the bow-string, the cord being raised by hand, and suddenly made to recoil upon the seed cotton. The force of this impulsion separated the seeds, and opened up the wool. From this practice, this class of cotton was called bowed Georgia, and is still known in the trade as boweds cotton. Women of all Hindoo castes prepare the cotton thread for the weaver, spinning the thread on a piece of wire, or a very thin rod of polished iron, with a ball of clay at one end; this they turn round with the left hand, and supply the cotton with the right; the thread is then wound upon a stick or pole, and sold to the merchants or weavers. For the coarser thread, the women make use of a spinning-wheel, very similar to that of the English spinster, though of a smaller construction. The tanties, or weavers, are in six divisions, and they have no intercourse with each other so as to visit or intermarry. The cotton when spun is delivered to the winders, who are frequently the younger wives or girls. The winding machine consists of three parallel bars of wood laid flat on the ground, and kept in their places by a cross piece. From the upper surface of the bars pegs stand up, round which the yarn is wound from the bobbins in a horizontal direction. The coarser yarn is used for the chain or warp of the web, the finer for the woof. The former is prepared for the weaver by boiling it in hot water, and then plunging it into cold; but the woof, being usually less coherent, is strengthened by the gluten of cow dung, for it is first soaked in water mixed with a little of that substance, then wrung out, laid in a covered vessel for some days to become uniform, and lastly dried in the sun. The next process is warping. The machine used for this purpose consists of a straight range of bamboo sticks, about 3ft. long, stuck on end in the ground, 2ft. apart. Young persons are taught to run nimbly, with the bobbins in their hands, along that range, interlacing the yarn round each stick upon alternate sides, and applying it uniformly by means of a guide composed of a bamboo having a ring fastened to its point. When the warping is finished, additional sticks are inserted between the others to keep the yarns in their position, after which the whole is rolled up with the bamboos, immersed in a tank of water for a short time, and trodden with the feet to ensure its thorough saturation. It is next taken out, dried, remounted by fixing the bamboo sticks once more in the ground, and carefully examined by the weaver to see what threads are broken that he may mend them. The sticks being now withdrawn, the warp is laid along trestles about a yard high, placed at regular distances, and is rubbed over with rice water of a mucilaginous nature, kept till it has become sour. This corresponds to the weaver's dressing in Europe. The chain of yarn must now be carefully arranged, first with the fingers, and then with a whisk of slender twigs, in order to place the threads truly parallel, as well as to smooth and clean them. Lastly, a mucilage of boiled rice is spread over the warp to stiffen it, and when dry it is softened by rubbing with oil. It is now ready for the loom. This process was deemed so important as to be regulated by ancient statute. "Let a weaver who has received ten patas of cotton thread give them back increased to eleven by the rice water, and the like used in weaving; he who does otherwise shall pay a fine of twelve panas." The tanty, or Hindoo weaver, digs first a hole in the earth for his legs, so as to be conveniently seated on the ground. He then drives two strong bamboo stakes into the earth at a distance apart proportional to the breadth of his web, and near enough to a wall or a tree for fixing the stakes to it by slender bamboos. The primitive oriental loom consists merely of two roller beams resting on two pair of stakes driven into the ground, and two sticks which cross the chain or warp, and which are supported at each end, the one by two cords tied to the palm tree under whose shade the loom is placed, and the other by two cords fastened to the foot of the weaver. These enable him to part the alternate yarns for the purpose of traversing the warp with the woof. A very rude stick or wooden bar serves the weaver for a shuttle, which answers also the purpose of a batten for driving home each woof yarn against its predecessor, so as to give the cloth the proper closeness of texture. The loops beneath the gear, into which he inserts his great toes, serve for treadles; and, with his long shuttle he both draws the weft through the warp and closes it up. With such awkward mechanism as this are woven those muslins of aerial fineness, transparent and delicate as the gossamer web. The reed is, indeed, like our own, and is the only thing made with the appearance of mechanical skill.

In many districts of England a most laudable zeal to encourage the arts prevailed at an early period of their growth. Thus, the warden and fellows of Manchester College, in order to lead ingenious strangers to settle in their town, granted them, nearly two centuries ago, the benefit of their extensive woods to cut timber for constructing their looms, as well as for fuel, at the trifling annual charge of 4d. each. The pre-eminence of Lancashire in manufactures soon after Elizabeth's accession is well marked by an act of Parliament in the eight year of her reign, for regulating the aulneger or cloth measurer, an officer originally created by Richard I. The aulneger is here empowered to appoint and have his lawful deputy within every of the several towns of Manchester, Rochdale, Blackburn, and Bury, in the said county.

PART II.—*Mediæval History*.

From 1760 to the close of the century, some of the most important mechanical inventions were produced, all tending to the development of an increase in the productive power of cotton machinery. Thus, as steam power is of prime importance in this country for driving such machinery, we find that Watt was directing his powerful mind to the improvement of the steam engine, with what success need not here be told, while at the sume time Brindley was engaged in constructing water ways to enable his employer, the Duke of Bridgewater, to convey coals from Worsley to supply the all requisite fuel for raising the steam, which would be required by Watt's engines, and to bring cotton from Liverpool to Manchester for the cotton mills which would be driven by those steam engines. Doubtless the presence of immense quantities of coal in Lancashire, and the close contiguity of the port of Liverpool, had much to do with causing that county to be, as it is, the chief seat of cotton manufactures in this country. From 1760 to 1830 the inventions of Paul, Arkwright, Crompton, Hargreaves, Kay, and others, really laid the foundation of the present system of power or cotton factory operations as compared with hand or domestic working. For during that period the principle of nearly every machine now found in our cotton mills was determined, thus tending to increase our admiration for the wonderful skill and ingenuity of those founders of the cotton trade. In a paper read by Mr. Kennedy before the Manchester Literary and Philosophical Society in 1815, he says: It will be proper, perhaps to take a retrospect of 50 or 60 years, in order to show the changes that have taken place from time to time to the present day, before we can appreciate the advantages or disadvantages as well as the causes of these changes, in the progress of cotton manufactures. With regard to the operation of weaving, I believe it will be admitted that it remains nearly the same as it was 50 or 60 years ago, or indeed at any period, or in any country where the people have been in the habit of weaving for a subsistence, with the difference only of the application of the fly-shuttle, which was invented and introduced about the year 1750. by Mr. John Kay, of Bury. At that time the cotton was carded and spun by band in the weaver's family, and the manufactory was carried on to an extent sufficient to supply a limited home consumption. Even then, however, there were frequent fluctuations in the demand for cotton fabrics, the causes of which may have proceeded from a variety of circumstances, such as an occasional scarcity of food, or any other obstruction to the progressive improvement of the country. Under such circumstances, when a stagnation took place it was natural that the manufacturer would, rather than be out of employment, endeavour to find a market for his goods in other countries; and, from this principle, arose a foreign trade, with all its train of changes and fluctuations, much greater, perhaps, than the fluctuations of the home trade which preceded it; and the consequences were, I believe, nearly as follows:—With their new connections, the manufacturers soon found that they could not supply the increased demand for their cloths,

and the first consideration was, how they were to produce a greater quantity in their respective families. It naturally occurred to them that, if they had another loom, or another hand to spin, they might be able to supply this additional demand. But if they were all employed before this could not be done, unless they could make some arrangement by which the same number of hands might produce a greater quantity of cloth. By separating their different operations, and dividing them with some order between the different members of the family, they found that more could be produced; but in the small compass of a single family, division of labour could not be carried far. The next consideration was, cold they get a neighbour to card or to spin for them, they might then be able to weave a still greater quantity. The attention of each being thus directed to fewer objects, they proceeded imperceptibly to improvements in the carding and spinning, by first introducing simple improvements in the hand instruments with which they performed these operations, till at length they arrived at a machine which, though rude and ill-constructed, enabled them to produce more in their respective families. Here, then, commenced a great deviation from their former methods of proceeding; and invention and ingenuity found their reward in the construction of machinery for carding and spinning. But to return to the division of labour, and the small improvements made by the workers in the hand implements which they used. They found that by these means they could obtain more of the comforts of life, and have more time to amuse themselves. Thus, they were induced to go on till their cottages were filled with their little improvements, and they were in some measure forced out of their dwellings by the multiplication of their implements. Here commences the factory system, and the dividing one branch of the trade into two distinct parts, carding and spinning. The first of these improvements was the carding, by means of which one boy or girl could work two pairs of stock-cards, so as to produce more than they did formerly. This continued for a short period, when further improvements followed, until one person could work four or five pairs, by holding hand-cards against stock-cards fixed to a cylinder revolving on its axis, now called a carding machine, the inventor of which we have no account of. It was, however, partially in use, in this rude state, about 60 years ago. About 10 years afterwards this was followed by another machine, called the spinning jenny, invented (in 1767) by Mr. Hargreaves, of Blackburn, by means of which a young person could work 10 or 20 spindles at once. In following up these important improvements it was found that rotatory motion might be applied with advantage to almost all the new machines, and the turning of these separate machines by hand required, as they were multiplied, a great expenditure of human labour. The next grand step in the extension of the manufacture was the application of the power of horses to this purpose. But this also soon found its limits, and waterfalls were resorted to. But in resorting to waterfalls to avail themselves of their power, the manufacturers were again removed from the experienced workmen in wood and metal, as well as from their neighbours, whose families had become essential parts of their enlarged establishments. In some instances men of landed property stepped forward, and joining the industrious manufacturers with their capital, colonised near the waterfalls for their convenience. This created a new demand for artificers in various branches, and these men felt their interest likewise in the increasing manufactures. The artificers also improved rapidly in their respective branches and became very useful in the construction of machinery. With the advance of wages their dissipation increased; yet, with their increased dexterity, the produce of their labour was much greater in the same time, and much better in quality, than formerly. By degrees, a higher class of mechanics, such as watch and clockmakers, whitesmiths, and mathematical instrument makers began to be wanted; and, in a short time, a wide field was opened for the application of their more accurate and scientific mechanism. These workmen were first chiefly employed in constructing the valuable machines invented by Mr. Arkwright. A description of these machines would extend this paper beyond my present intention. It is but justice, however, to observe, that Mr. Arkwright's inventions introduced principles entirely new into both carding and spinning (now commonly called perpetual carding and spinning), by first disengaging, then laying, the fibres of the cotton parallel to each other, and disposing them much more uniformly in the thread than it was possible to dispose them by any of the methods previously in use. At that period, millwrights, as well as the superior workmen above mentioned, were more generally employed in the establishments for spinning cotton than formerly, and a new stimulus was given to almost all kinds of manufactories then in the country, extending their circle wider and wider, and increasing the general demand for labourers, until it became very difficult to find a supply for the extensive works that were being erected. During a period of 10 or 15 years after Mr. Arkwright's first mill had been built (in 1771), at Cromford, all the principal works were erected on the falls of considerable rivers; no other power than water having then been found practically useful. There were a few exceptions where Newcomen's and Savary's steam engines were tried. But the principles of these machines being defective, and their construction bad, the expense in fuel was great, and the loss occasioned by frequent stoppages was ruinous. In the year 1780, a new and valuable machine appeared, called, at that time, the Hall-i'the'-wood machine, from the name of the place where the inventor, Mr. Samuel Crompton, lived, near Bolton, in Lancashire. It is now called the mule, from its uniting the principles of Mr. Hargreave's jenny and Mr. Arkwright's water frame. This machine, by producing, at a small expense, much finer and softer yarn than any that had ever been seen before, gave birth to a new and most extensive trade. The mule commenced much like the jenny, and its operations were carried on for many years in the country, and in private families, but without the benefit of Mr. Arkwright's patent machinery for carding and roving, which required constant and regular motion. The want of regular power and of skilful mechanics soon brought the mules to the neighbourhood of towns; and about this time (1790) Mr. Watt's s steam engine began to be understood and introduced into this part of the kingdom, and it was applied to the turning of these various machines. In consequence of this, waterfalls became of less value, and instead of carrying the people to the power, it was found preferable to place the power amongst the people wherever it was most wanted. The introduction of this admirable machine imparted new life to the cotton trade. Its inexhaustible power and uniform regularity of motion supplied what was most urgently wanted at the time, and the scientific principles and excellent workmanship displayed in its construction led those who were interested in this trade to make many and great improvements in their machines and apparatus for bleaching, dyeing, and printing as well as for spinning. Had it not been for this new accession of power and scientific mechanism, the cotton trade would have been stunted in its growth, and, compared with its present state, must have become an object only of minor importance in a national point of view. And, I believe, the effects of steam engine have been nearly the same in the iron, woollen, and flax trades. Before the year 1790 the mules were turned by hand, and were confined chiefly to the garrets of cottages. About that time Mr. Kelley, of Lanark, first turned them by machinery. The application of the steam engine to this purpose produced another great change in this branch of the trade. The mules were removed from the cottages to factories, were constructed more substantially and upon better mechanical principles, and produced yarn of a more uniform quality and at less expense. The fine fabrics made of the yarn spun upon mules surpassed in beauty and cheapness everything that had been produced before, and the demand for them was consequently great. Larger establishments were erected, and order, system, and cleanliness in their arrangement and management became more necessary and more generally cultivated. This has been attended with good effects on the habits of the people. Being obliged to be more regular in their attendance at their work, they became more orderly in their conduct, spent less time at the alehouse, and lived better at home. For some years they have been gradually improving in their domestic comforts and conveniences. In 1797, a new machine for cleaning cotton was constructed by Mr. Snodgrass, and first used at Johnston, near Paisley, by Messrs. Houston and Co. This is called a scutching or blowing machine. Its merits were but little known till 1808 or 1809, when it was introduced into Manchester by Mr. Kennedy, and it is now generally adopted for cleaning cotton. The labour of that operation—formerly performed by women, in a most fatiguing manner, and always considered as degrading—has been reduced by this machine to about one-twentieth of what it used to be.

(*To be continued.*)

THE MAHROUSSEE.

Such is the name of the new steam yacht of the Pacha of Egypt. It was designed by Mr. Lang and built by Mr. Samuda. The engines were constructed and put on board by Messrs. John Penn and Son. Her length between perpendiculars is 360ft.; length over all is 400ft.; the breadth is 42ft.; depth is 29ft.; and tonnage, 3,141. Her propelling power consists of a pair of Penn's 400 horse power engines, (together 800 horse power nominal), with oscillating cylinders, their diameter being 100in., and their stroke is 8ft. Each cylinder weighs 26 tons, complete, and their intermediate shaft weight 27 tons. The boilers are ranged on the fore side as well as on the aft side of the engines, and between the engines and the stoke holes, which is a very desirable arrangement in a warm climate. There are no less than sixteen furnaces in each stoke hole. The paddle wheels are of the feathering description, 28ft. diameter and 33ft to their extreme diameter. The finish of these engines is spoken very highly of.

The keel of the *Mahroussee* was laid in January of last year, and the vessel has been admired as a specimen of naval architecture. The fine engine room is upwards of 20ft. in height, and affords a noble space for

displaying the just proportions, and high finish of Penn's celebrated factory. The coal bunkers have a capacity for 950 tons. The ship's displacement at 15ft. 2in. forward and 15ft. aft was about 3,135 tons, and the area of her midship section is about 500 square feet. She made a trial trip on the 25th ult. over the measured mile course in Stokes Bay. The steam pressure is given at 30lbs., vacuum 27in., and the revolutions of the engines 26. Indicated horse power was 6,400. Six runs were made and a mean speed obtained of 18,534 knots, or 21½ miles per hour. This rate places this steamer in the first rank of our fastest boats. Hitherto the Dublin and Holyhead boats shared this distinction with the Queen's yacht.

But this yacht has been finished with a due regard at once to accommodation and elegant taste, which appear to demand further notice, her fittings being pronounced to be unparalleled in their splendour. Forward of the engines the arrangements are very complete for the accommodation of the officers and crew; the ward-room is exceedingly capacious. In the after part of the ship—in the saloons and suites of apartments devoted to the use of the Viceroy, his ministers, and suite—is to be found the Oriental splendour which makes the *Mahroussé* in that respect the most magnificent vessel afloat. Entering from the upper deck, wide folding doors, under a lofty poop-deck, open into an ante-chamber glowing with gold and colours, and with a wide staircase having balustrades of electro-silver, and silver-gilt, leading to the royal apartments below. Passing this staircase, however, other doors open into a dining saloon, the panels of which contain paintings of fruits and flowers, on *papier maché;* the numerous windows draped with pale blue rich silk drapery, embroidered with a rich flowering pattern; the cushions covered with similar material; the columns supporting the roof of the cabin electro-plated; and the thousand and one wax-light shades which surround the saloon held in handsome silver-gilt sconces. Massive electro-plated chandeliers hang from the ceiling, and the richest carpets cover the floor. Underneath this brilliant apartment is another, of still greater splendour—the Viceroy's drawing room, with its adjacent ladies' retiring room. It is impossible to describe the extraordinary magnificence of these apartments. Gobelin tapestry of the most costly character hang from the walls; on the latter being at every interval of panels exquisitely-painted medallions. Tables of marvellous inlaid marbles, tables of gold, tables of wonderful work and grain in woods, gilded chairs, and rich damask-covered divans are scattered about over the floors wherever likely to be useful, and silver gilt sconces and chandeliers hang around to throw a flood of light over the whole. The Viceroy's bed-chamber, which adjoins the drawing room, is one worthy, in its proportions and decorations, of so high a prince. In the centre his Highness's bed stands, enveloped in mosquito curtains—a very temple of Momus. Pale slate-coloured draperies, chastely embroidered in coloured flowers, hang round the sides and windows; costly furniture stand in positions in the room where convenient, and all is arranged with exquisite taste. The Viceroy's bath-room, adjoining, contains a noble bath carved out of one block of marble. Forward of the Viceroy's sleeping apartment are the apartments of the Chief Minister and the Officers of State in attendance, all fitted without regard to cost. On the deck below the Viceroy's drawing room and sleeping apartment is a saloon and cabin for the accommodation of the Viceregal suite—the metal fittings, chandeliers, light sconces, &c., being all of electro-plate. The ventilation throughout all these apartments is very efficiently provided for by a scheme of large air-shafts which surround them, and through which air is driven by a fan and small engine that has been fitted for the purpose. It is with a feeling of relief that the eye can escape the glittering beauty of the Viceroy's apartments, and rest upon the grandeur of Mr. Penn's machinery in the engine-room of the ship. The room itself is upwards of 20ft. in height, and never perhaps before had any machinery a chance of being seen at work with equal advantage.

THE GREAT EASTERN.

At a general meeting of this company, held recently, we gathered a few interesting facts, concerning the future of this interesting steamship, and the prospects of its owners.

The chairman, in moving the adoption of the report and statement of accounts, said, the directors regretted being so late in holding the meeting, but the delay had enabled them to say that the new charter of the ship had been completed. The charter had been sealed by both parties, and was, he thought, a very favourable one for their company. It secured them £20,000 a year for the use of the ship, whether the laying the cable should prove successful or not; but, having been on board the ship last year, and having seen the whole of the operations in laying the cable, it had very greatly increased his confidence, and he thought it quite possible with proper tackle, to raise up the end of the cable already laid. They raised the cable up, about a mile, last year, but the tackle, being inadequate, broke. However, the ship would go out next time provided with proper tackle, and he had no doubt they would be able to raise the cable successfully and complete it, which would entitle them to the £50,000 preference stock The ship would first lay the new cable from Ireland to Newfoundland as she went out, which, if successful, would entitle them to £25,000 stock, and on her return would lay the remainder of the first cable; so that if they should be able to lay the two cables successfully, they would have the £50,000 preference stock for the first cable, and the £25,000 stock for the second cable, which would of itself make a very large dividend. Under the new charter, they were in receipt of £1,000 a month out of which they proposed to appropriate £6,000 for a dividend, at the rate of 12 per cent. per ann., by which they would be placed in the position, as *Great Eastern* shareholders, of having got one dividend out of the great ship.

The submarine cable is being coiled at the rate of two miles an hour in the vast tanks of the *Great Eastern.* The *Amethyst* hulk is moored alongside the great ship off Sheerness, while the *Iris* is being laden in her turn at Greenwich, and will supply the *Amethyst's* place directly the latter is emptied. The directors of the Telegraph Construction Company have chartered the *Medway*, a ship of 1823 tons, to accompany the *Great Eastern* on her voyage out. The *Medway* will carry some hundreds of miles of the cable of last year, and in the event of the expedition being successful will redischarge this into the empty tanks of the *Great Eastern* at Newfoundland. The *Medway* will then start to indicate the spot where the broken end lies, to place buoys, or it may be to commence the picking up. Captain Anderson, to avoid taking the *Great Eastern* to the Nore this year, will go direct to Beerhaven from Sheerness, and will there supply himself with coal for the voyage. The length of time to be occupied in an expedition during which the double process of laying down one cable and picking up another is to be gone through is necessarily estimated at a much higher rate than the one of last year, and some seventy days are spoken of as the period the *Great Eastern* will be away. Assuming her to leave Sheerness from the 29th June to 3rd July next, three days will take her to Beerhaven, where she will stay nine days to take in coal. Allowing five days for waiting for favourable weather, for splicing with the shore end, and fifteen days for the passage to Trinity Bay, we may look for messages from America about the middle of August next. The *Great Eastern* will again supply herself with coal at Trinity Bay, and at once follow the *Medway* to the grappling ground; this will take three days, and eight more are given for grappling, and five for returning to Trinity Bay and laying the remainder of the old cable. This done, the return of the *Great Eastern* to England will take twelve days more, and bring her home about the second week in September. In each case a margin must be given to the foregoing figures, but they are based on present calculations, and may be taken as authentic. It will be seen that they assume success throughout, and it may be added that on an elaborate series of problems having been drawn up by authority, as to what would be the effect of the different calamities or casualties, should they arise, the responsible leaders of the coming enterprise have answered every supposition satisfactorily in writing. The issue, time alone can solve; but whatever may be the result, the more the preparations for the Atlantic expedition of 1866 are known the more they will be regarded as marvels of forethought, of precaution, of skilful analyses of cause and effect, and of logical deductions patiently, laboriously, and courageously worked out.

ARMOUR-CLAD VESSELS.

We translate from *The Times*, of 30th April, an interesting letter, written in French upon the above subject, by M. Dupuy de Lôme, the well-known *Directeur du matériel* at the French Ministry of Marine. Naval architecture cannot afford, just now, any additional confusion. It must therefore be highly desirable to rectify an error whenever the opportunity is afforded, the more so when it is found associated with the names of men who are often quoted as authorities.

To the Editor of THE TIMES.

Sir,—In various highly interesting articles inserted in your journal relating to the trials in the Royal British Navy, especially in the article of March 20th last, about the *Bellerophon,* and that of April 19th, about the *Pallas,* you do me the honour of quoting, as being of a certain weight in this question, some opinions or theories ascribed to me with reference to the most suitable shape of ships' bottoms. Thus, I read in the article of 20th March:—"M. Dupuy de Lôme declares that the wave of water does not effect the speed of the ship. He argues that a certain amount of water lies in front of the vessel's midship section, which must be got rid of, that this water is ploughed up by the submerged portion of the ship's bow, and that this water exists thus broken up in the wave in front of the ship's bow, and is hurrying forward in the direction in which the ship is moving."

I also read in your article of the 19th April:—"The *Pallas* has been constructed with a submerged ram bow borrowed from the French theory

as exemplified by M. Dupuy de Lôme, in the partially plated ships *Magenta* and *Solferino*." I do not intend by any means to discuss any theory of the resistance which the water opposes to ships in motion. This short letter will not allow of going fully into the question. I only owe to truth to state that I never did, either verbally or in writing, set up a theory similar to the one erroneously ascribed to me in your article of 20th March; this theory even agrees in form with the *résumé* of the principles of the resistance opposed by the water to ships in motion, which was laid down in a notice I recently sent to the Academy of Sciences. I would only add one word with reference to the second article, relating to the *Pallas*, the outline of which is stated to be similar to that of the *Solferino*.

According to your article of the 19th of April, the *Pallas*, having a midship section of 790 square feet under water, a displacement of 3,700 tons, and indicated horse-power of 3,768 horse, had obtained in calm weather a speed of 13·057 knots by the measured mile. The *Solferino* having a midship section of 1,152 square feet under water, a displacement of 7,020 tons, and indicated horse-power of 3,720 horse has attained a speed of 14 knots. There are therefore considerable differences between the *Pallas* and the *Solferino*, both as regards the shape of the ship's bottom and the character of the screw, as well as the elements that affect the relation existing between the moving power of the ship, its displacements, area, midship section, and speed.

"As this question of utilisation of the motive power of marine engines is highly interesting to the science of naval construction, independently of the whole arrangement of the ship, from a military point of view, I thought, sir, that you would kindly insert this letter in your journal, so as not to allow any theories, which are not my own to be canvassed under my name.

Please accept, sir, the assurance of my distinguished consideration.

Dupuy de Lôme.

Paris, April 26th, 1866.

THE ROYAL WEST INDIA MAIL STEAM-PACKET COMPANY.

The half-yearly meeting of this company was held on the 25th April, at the London Tavern, Captain Mangles in the chair. From what passed we can glean a few professional and other matters, such as the experience of this important company may develope. We see that it opens a through communication between California and England without an interval of delay on the Isthmus of Panama, and in connection with the service which the Panama, New Zealand, and Australian Royal Mail Company, Limited, expected to commence next June, between Panama, New Zealand, and Australia, and together these companies would complete a monthly line of steam communication between this country and these colonies *viâ* Panama. This company has been in existence twenty-four years. There was a difference of only £260 between the expenses of the past year and those of 1864. The item for provisions had been more, in consequence of the increase in the number of passengers. With regard to the item of washing, they had, by introducing machinery effected a saving of £750. Other savings were intended; by erecting washing machinery at St. Thomas's, &c., and so reduce the expense which had been some thousands a year. The receipts from passengers exceeded that of the preceding year by £10,000, and during the past ten years the receipts from that source had increased by nearly £100,000. It was contemplated to issue return tickets from England, to New Zealand and Australia, which might be advantageous to both companies, and afford facilities to travellers to circumnavigate the world in four or five months, by means of their route from Southampton to Australia. Such passengers could return, by the Peninsular and Oriental Company's steamers, to Southampton, *viâ* the Red Sea.

The consumption of coal is an item of considerable importance to every steam ship company. The average consumption for a year of these long voyages was 1,950 tons per voyage. The consumption on board the *Douro* however was but 1,607 tons, and the *Rhone*, 1,570 tons. The last of the new ships was the *Douro*, and her performance was most satisfactory.

The average speed of their ships was 10½ knots an hour. The speed of the *Oneida* was 10·58 knots; of the *Rhone*, 10·56 knots; of the *Atrato*, 19·74 knots; of *La Plata*, 10·20 knots; and of the *Tamar*, 10·65 knots per hour. The speed for the Brazilian service was 9½ knots per hour. The speed of the *Oneida* on that route was 9·52; of the *Parana*, 9·76; of *La Plata*, 9·95; of the *Douro*, 10·30; and of the *Rhone*, 9·91. These steamers not only kept their time, but gave the public the advantage of greater speed than the company were paid for.

The cost of the old ships had been gradually written off, so that there was now a balance under that head of £25,000, and when the last was disposed of, there would be a clear balance to the credit of that account of £20,000. The satisfactory state of the company's insurance fund showed the great care taken by the captains and officers of their ships. Their commanders were requested, on every voyage, to keep time, if possible, but above all things to take care of the ships and passengers.

In steaming across the Pacific their ships would run a distance of 6,500 knots, without touching anywhere, and that at a rate of 10 knots an hour the whole way. Their speed frequently rises to 11 or 12 knots, and their daily consumption of coals is often less than 30 tons.

Institution of Mechanical Engineers.—The annual meeting of this Institution is announced to be held at Manchester, on Tuesday, Wednesday, Thursday, and Friday, the 31st July, and the 1st, 2nd, and 3rd, of August.

PRICES CURRENT OF THE LONDON METAL MARKET.

	April 28.			May 5.			May 12.			May 19.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	94	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	91	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	1	0	0	0	11¾	0	0	11¾	0	0	11¾
„ tubes, do.	0	1	0¾	0	1	0¼	0	1	0¼	0	1	0¼
Sheathing, per ton	96	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	101	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	7	10	0	7	10	0	7	10	0	7	10	0
Nail rods, do.	8	7	6	8	7	6	8	7	6	8	7	6
„ Stafford in London, do.	8	15	0	8	15	0	8	15	0	8	15	0
Bars, do.	8	15	0	8	15	0	8	15	0	8	15	0
Hoops, do.	9	15	0	9	15	0	9	15	0	9	15	0
Sheets, single, do.	10	7	6	10	7	6	10	7	6	10	7	6
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	3	19	0	3	6	0	2	16	0	2	15	0
LEAD.												
English pig, ord. soft, per ton	21	7	6	21	7	6	21	7	6	21	5	0
„ sheet, do.	21	15	0	21	15	0	21	15	0	21	15	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	20	5	0	20	5	0	20	5	0	20	5	0
BRASS.												
Sheets, per lb.	0	0	10¾	0	0	9	0	0	9	0	0	9
Wire, do.	0	0	10½	0	0	8¾	0	0	8¾	0	0	8¾
Tubes, do.	0	0	11½	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	15	0	1	14	0	1	13	0	1	13	0
IX „ „ „	2	1	0	2	0	0	1	19	0	1	19	0
IC „ 2nd qua., „	1	13	0	1	12	0	1	11	0	1	11	0
IC Coke, per box	1	8	0	1	6	6	1	6	6	1	6	6
IX „ „	1	14	0	1	12	6	1	12	6	1	12	6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Fernie *v.* Young.—This was an appeal from the Court of Chancery. An injunction had been granted to restrain the appellants from continuing an alleged infringement of the respondent's patent for the manufacture of paraffin oil. In the court below there was a preliminary trial of certain issues of fact, and the decree for an injunction was afterwards made. It was now objected that it was not competent to the appellant to bring before the house any appeal against the finding those issues of fact, but that the proper course would have been to apply for a new trial on the matters of fact. The point was argued at great length, when their Lordships said that the house had no power to do anything further than to decide whether the decree of the Court below was or was not right, and it was not competent to their Lordships to deal with the issues which were the subject of the trial and verdict preliminary to the making of the decree; but the appellant was at liberty to argue against the decree merely. The other matter could only be the subject of a motion for a new trial of the issues of fact. Eventually their Lordships, without hearing the counsel for the respondent, dismissed the appeal with costs.

Penn *v.* Jack *v.* Bibby and *v.* Fernie.—We referred to this case in our last issue; since then the Vice-Chancellor, Sir W. P. Wood has given his decision. It will be remembered that this suit was to enforce the claims of the patentee, for the use of fillets of wood in the screw-shaft bearings. The trial lasted several days. His Honour intimated that he was prepared to decide in favour of the plaintiff upon the legal questions arising out of the construction, but that he would postpone his judgment until he gave his decision upon the evidence. The Vice-Chancellor, in the course of a long and elaborate judgment, said that the importance and value of Mr. Penn's invention, was established by evidence of the very highest character, and a more immediate or general adoption of any invention could hardly be met with. The defence relied upon was mainly,

that there was no novelty in the use of wood as a material for bearings, and that such use was not a fit subject for a patent, as it had been adopted years since in the bearings of waterwheel shafts, was a well-known material for bearings of every description of machinery, and was mentioned in no less than four patents, all antecedent to that of the plaintiff. A very strong answer, however, to this defence was to be found in the fact, that, although the use of wood for the bearings of water-wheels, was, undoubtedly, common enough, and was within the knowledge of scientific men, no one until the plaintiff (omitting the case of the *Livorno*), had ever thought of applying it to screw-propellers, although the defects of metal bearings were patent, and a remedy for these defects was the great desideratum among scientific men. It was perfectly idle to contend that the existence and use of wooden bearings for the shafts of waterwheels had anything whatever to do with the application of wood to the bearings of a screw-propeller, a thing so totally different in weight, and also in rapidity of revolution. With respect to the patents that had been given in evidence on behalf of the defendants, they really had nothing whatever to do with the question. They might be dismissed altogether, containing as they did, mere recitals of the useful adoption for the bearings of machinery, of wood among other materials, and being wholly unsupported by any evidence of user. The case for the defence, which was rested on the anticipation of the patent by the use of wooden bearings in waterwheels, and by the recitals contained in certain previous patents, had, in his opinion, failed altogether. His honour then proceeded to discuss the legal questions which had been raised on the construction of the specification, and held that the invention, and manner of performing the same, were sufficiently described in the specification, and held that the claim was not bad as being too vague or general. He then came to the case of the *Livorno*, which was stated to have been fitted with wooden bearings in May 1851. He felt bound to say, that if it were proved distinctly that blocks of wood had been deliberately fitted into the bearings of that steamer, by the chief engineer, if it were proved that this was done openly, at the shipwright's yard, without any pledge to secrecy, and with the assistance of the second engineer and carpenter, and that the bearings thus fitted, were used successfully during the voyage to the Mediterranean. If all this had been distinctly proved, then there would be that distinct and public user of the invention which would avoid the plaintiff's patent by anticipation. The evidence, however, was very conflicting, and rendered the duty of deciding between the witnesses very painful. His Honour after commenting at some length upon the evidence given upon this point, the singular character of the story put forward by the defendants, and the absence of some of those persons who might have been expected to come forward and support the statement, said that the defendants had failed to establish any such user of the invention as could be allowed to anticipate the plaintiff's patent. It was extremely probable that some experimental attempt was made by the man Greenshields, on whose evidence this alleged prior user in reality wholly rested, but the attempt had failed, and this would account for the absence of the model and drawings made by Greenshields (said to have been burnt), and the singular want of publicity, or even communication to the owner of the ship and consulting engineer, of this great and important discovery. The defendants, in his opinion, had failed to establish the burden which rested on them, of disproving the novelty of the plaintiff's patent. The finding, therefore, would be for the plaintiff upon all the issues. Some discussion then took place as to the hearing upon motion for decree. It was ultimately arranged that the defendants should serve notice of motion for a new trial for the first day of next term, and that the hearing of the cause should stand over until the first cause day after the second seal day in next term.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

BRADFORD RESERVOIRS.—Mr. Rawlinson's report to the Home Secretary, dated in March, has been laid before the House of Commons. It states that the discovery of a leak through the puddle in Doe-park reservoir embankment, and the leaking condition of the puddle and masonry shaft of the valve-well at Grimwith, are a justification of Mr. Ferrand in having drawn attention to the state of those embankments. The leaks through the masonry joints are not at present necessarily dangerous, but they will require to be constantly watched. There are no special elements of danger in the Doe-park embankment like those which existed in the Dale-dyke embankment above Sheffield, which burst in March, 1864. Former experience shows that the Doe-park reservoir can be filled and emptied with safety; and filling it will alone be a reliable test of the embankment being water-tight and sound. Mr. Rawlinson's recommendation is, that the Doe-park and Grimwith reservoir embankments, be cautiously filled after the repairs have been completed, and that there be regular watching, night and day. He is satisfied that no such catastrophe as that which took place above Sheffield, need be apprehended at Doe-park.

THE PARIS EXHIBITION, 1867.—The following table (corrected to the present date) gives, in square feet, the amount of space allotted to each country by the Imperial Commission:—France and French Colonies, 689,492; Great Britain and Dependencies, 225,740; Prussia, 81,031; States of the Zollverein, 81,031; Austria, 81,031; Belgium, 78,027; Italy, 41,850; Russia, 31,387; United States of America, 31,016; Switzerland, 26,005; Sweden and Norway, 22,507; Holland and the Dutch Colonies, 21,506; Spain and her Colonies, 21,463; Turkey, 13,950; Portugal and her Colonies, 12,206; Brazil, 10,462; States of South America, 8,719; China, Japan, and South Asia, 8,719; Africa and Oceania, 8,719; Denmark, 6,996; Greece, 6,975; Danubian Principalities, 6,975; Rome, 6,975; Persia and Central Asia, 6,975; Mexico and Central America, 6,975. The space assigned to each country is in every case enclosed between two radiating lines running directly from the avenue surrounding the central garden to the extreme circumference of the palace, the entire ellipse, being as it were made up of 26 more or less wedge-shaped divisions, with their smaller ends always resting on the central garden.

ACCIDENTS IN THE METROPOLIS.—A return was issued lately showing that the number of persons run over and killed in the streets of the metropolis during last year, was 140. Of this number 124 were killed where horses were being driven, and the remainder where they were being led. In the same year 1707 persons were injured; 1647 where the horses were driven, and 60 where they were led. To the end of February in the present year 23 persons were killed, and 231 injured from the same causes, the high proportion between the accidents which occurred from driven and led horses being kept up. In the City Police district, last year, 14 persons were killed in the streets and 207 injured. In the same district up to Feb. 26th of the present year, 3 were killed and 30 injured.

GROWTH OF MARSEILLES.—The great prosperity of Marseilles is owing to its soap manufactories, which are 62 in number, and annually consume 1,200,000 cwt. of oleaginous seeds, 150,000 cwt. of olive and other oils, 250,000 cwt. of raw sulphur, 425,000 cwt. of soda, 29,000 cwt. of nitrate of sodium, 165,000 cwt. of sea salt, and 200,000 tons of coal. Every hectolitre of oil yields 169 kilogrammes of soap.

A ROTARY ROCK BORING DRILL.—Among the patents recently issued at Washington is a rotary rock boring machine, which consists of a drill composed of a number of scolloped cutting wheels, which are arranged in a common head, on axles passing through said wheels at right angles, and in such a manner that by giving to the head a rapid rotary motion, the wheels will cut into the ground or rock and produce a clear hole. The dirt or dust is raised by the action of a spiral flange, secured to the outside of the drill rod, guided by conveniently arranged friction rollers. A stream of water is made to pass continually to the bottom of the hole through the drill rod, which is made hollow for that purpose. Much of the dirt is thus removed. The machine can be applied to ordinary rock drilling or well boring.—*American Paper.*

THE AREA OF THE UNITED STATES, according to Land Office measurements is 3,002,018 square miles. This is equal to 1,921,288,233 acres of land, of which 1,400,549,033 are public lands for sale by the Government Land Office. Only one-fourth of the country is inhabited to any great extent by civilized people.

THE NEW PORTABLE SELF-ACTING FIRE-ENGINE.—On April 10th, Mr. Edward Casper, licensee of "L'Extincteur," gave a series of experiments with it on the Metropolitan Railway ground, Long-lane, Smithfield, in presence of a considerable number of gentlemen, amongst whom were Mr. David J. Isaacson, of Isaacson and Co., the Hague, representative of Lloyd's, insurance companies, and the mercantile marine service. A number of engines charged with seidlitz compound, air-tight, and capable of bearing a pressure of 150lbs. to the inch, were ranged upon a bench, and a raft of timber, about 5ft. high and 20yds. in length, with shavings and tar barrels beneath, also a wooden tank 12ft. by by 10ft., filled with tar, having been prepared, Mr. Casper addressed the company. He explained the principle of the new fire-extinguisher, which, once charged, is efficacious for an indefinite period, and the operation of re-charging so simple, as to be safely done by any lad. He invited any number of gentlemen to give orders when the raft was to be fired, and reckon reasonable time to enable it to assume such dimensions as might befal a City warehouse or private building. The raft was fired, and a machine being slung upon the shoulders of one of the licensee's *employés* the tube was applied to the burning pile. In three minutes the fire was put out. The tar tank was next set on fire; vast volumes of smoke and fire shot upwards, and the heat was intense. Two machines attacked this formidable conflagration, and in one minute and a half it was utterly subdued. Both rank and raft were relit, and even speedier extinguished than before. At each successive feat great applause greeted Mr Casper's experiments.

SUGAR CULTIVATION IN THE SANDWICH ISLANDS.—It appears that the cultivation of sugar in the Sandwich Islands has been found extremely profitable, and to have made proportionate progress. The export, which was 3,005,504lbs. in 1862, advanced to 10,414,411lbs. in 1864. New plantations are being constantly started, and the shipments this year are expected to be far larger than the last, while the area of land still untouched by cultivation, but capable of profitably producing sugar, is supposed to be ten to twenty times the quantity now yielding.

RAILWAY BRIDGES IN THE METROPOLIS.—The queston of noise from passing trains, so much complained of, was recently raised in a conversation between Mr. Scholefield, the chairman of one of the Commons railway committees, and Mr. Hawkshaw. Mr. Scholefield desired to know whether the noise consequent on the passing of trains over the railway bridges in London, could not in some way be obviated. Mr. Hawkshaw gave it as his opinion that this excessive noise was mainly due to the construction of these bridges being entirely of iron. He stated that this mode of construction was insisted on by all the parochial authorities; but that if these bodies would allow the bridges to be made of brick or stone, as formerly, the noise caused by passing trains would be very little, and, indeed, with proper precautions, might be almost entirely obviated.

THE MOST CURIOUS WORK at present going forward in Paris, is the levelling the hill of the Trocadero, on the right bank of the Seine, opposite the bridge of Jena. One-fourth of the work is already completed. Four mines are fired simultaneously by means of an electric battery. A surface of more than two acres is raised by each explosion, and waggons are ready on a temporary railway to remove the earth thus loosened.

STEAM OMNIBUSES are, it is said, to be established in Paris. The company propose to run from the Champ de Mars to the Bastile, making six halts. The first is to be at the Champ Elysees, the second at the Madeleine; the third, near the new opera on the Boulevard des Capucines; the fourth near the Theatre of the Gymnase; the fifth at the Porte St. Martin; and the sixth at the Chateau d'Eau. The omnibuses, drawn by horses, take an hour and twenty minutes to perform the distance; the steam company undertake to accomplish it in forty-five minutes, including stoppages. The existing omnibus company protest against the organisation of the steam company as a violation of their contract.

BURSTING OF A WATER MAIN AT LIVERPOOL.—On the 28th April much consternation was occasioned in Water-street, from the fact that the lower surface of one pipe had been blown out, at least two feet in length. A large body of water, of course, escaped into the neighbouring "cellars." It appears that the three foot main from Kensington is reduced to two feet at the bottom of London-road, and again to 18 inches just opposite the Town Hall. It was a few feet beyond this latter reduction, in the 18in. pipe, that the fracture occurred. Can any of our obliging correspondents at Liverpool inform us if the fracture was the direct or indirect result of pressure on the contained water; and what was the thickness of the metal of the pipe where ruptured? It might have been an old sore after all.

CONTAGION.—We see announced a pamphlet by James Dewar, M.D., "On the application of Sulphurous Acid Gas to the prevention, limitation, and cure of contagious diseases." If the arguments of this gentleman be correct they must go far to explain the freedom of overcrowded London from these diseases, seeing the abundance of this selfsame gas, which our gas companies so liberally distribute daily or nightly. Are we expected to be grateful to them for this adventitious if not questionable boon?

THE LOCUS STANDI OF TOWN COUNCILS ESTABLISHED.—Hitherto our town councils had no position before a parliamentary committee on railway bills. It seems that some of these bodies had petitioned against, and opposed with their usual pertinacity, the Caledonian and Scottish, North Eastern Amalgamation Bill, but had no position until a formal recognition was passed in these words: "The referees are of opinion that the provosts, magistrates, and town councils of the royal burghs in Scotland have a *locus standi* in cases where their petitions allege injury to the general interests of the inhabitants."

Steam Enterprise in Scotland.—On the 3rd ult. the steamships Camperdown, Victor, and Ravenscraig arrived in Dundee, from the seal fishing. The first-named vessel left Dundee on the 1st March, and arrived in Shetland on the 4th, where she only staid to complete her complement of "hardy tars," and then proceeded for "the ice," which she reached on the 27th March. She soon afterwards commenced "sealing," at which work the men were engaged about five whole days. It is estimated that her 22,500 seals will yield from 250 to 260 tons of oil. The Victor caught about 12,000 seals, which are expected to produce 130 tons of oil; she was engaged about six days. The Ravenscraig had about seven days' fishing, and made a total catch of 6,638, which are expected to yield about 80 or 90 tons of oil. We have here another evidence of large and quick profits ensured by steam.

MILITARY ENGINEERING.

The Seven Inch Palliser Gun.—The trial of the 68-pounder cast iron gun which was converted by Major Palliser into a 7in. rifled gun was brought to a conclusion on the 6th April. by the breech gradually giving way. For several rounds the cascable had been observed to be loose, and at the 904th round a large crack, about a quarter of an inch wide, was observed, which ran round about two thirds of the circumference at the breech. The practice was accordingly stopped, and the bore of the gun was examined and found to be uninjured. Major Palliser, and Captain Alderson, Royal Artillery, who was conducting the experiment, after due consideration, determined to fire another round in order to ascertain whether the gun would burst and scatter its pieces in all directions when the breech was blown out. The men were sent well under cover, and the gun was fired as before with 22lbs. of powder and 115lb shot. As was expected the end of the tube and the breech of the gun were blown out to the rear, but the gun did not burst out sideways, and no casualty could have occurred had a detachment of artillerymen been serving the gun in the usual manner. Major Palliser attributed the ultimate failure of the breech to the female screw thread which received the cascable not having been continued right through the cast iron breech of the gun, and observed that this thread, which was intended to have been the plus thread, upon which he lays so much stress, by this mistake actually became a minus thread, and the cast iron casing had been divided by a fracture which passed through the last complete turn of the screw thread inside of the gun. The result of the trial is considered very satisfactory, and a complete answer to the only objection which has been raised to this system of constructing guns—viz., that eventually they would burst explosively without giving any warning. Had the last round not been fired it might have been boasted that the gun had fired 904 rounds without bursting; on the other hand, the opportunity of gaining much valuable information would have been lost. It should be stated that that gun weighs only 5¼ tons, and at that time of the accident it was firing the heavy battering charges which are only to be employed on special occasions in the wrought iron 7in. guns of 7½ tons weight. The gun was firing these charges at 18° 54', which is the highest elevation the carriage would admit of, and it had only 17 rounds more to fire to complete its endurance test. As yet there is nothing with which the performance can be compared, as none of the heavy 7in. wrought iron guns have as yet fired half as many rounds. The range of the gun at 18°, 54' was 6,450 yards. A strong wind was blowing up the range, which, it was considered, diminished the range by about 300 yards. It is an interesting fact that at the last round, although the breech of the gun was blown out, the shot went up 6,391 yards. It is stated that the range and accuracy of the gun have never been exceeded. A 9in. rifled gun, which at present is being prepared for Major Palliser by the Elswick Ordnance Company, is expected shortly at Woolwich. The trial of this gun is looked forward to with much interest, and should it be succesful will establish the truth of Major Palliser's theory, that so long as the interior of a gun consists of a double coiled wrought iron tube, it is a matter of complete indifference whether the casing be composed of steel, cast iron, or wrought iron.

NAVAL ENGINEERING.

The "West of England," a new iron screw steamer, has been launched from the shipbuilding yard of Messrs. Bowdler and Chaffer, at Seacombe. The steamer has been built for Messrs. Pennington and Hough, of the Liverpool and London Steamship Company, Liverpool, and is intended as a trader between Liverpool and London. She is 185ft. in length, with a beam 28ft., and a depth of 17ft., and is fitted up with excellent accomodation for first and second class passengers. She is built so as to permit of the introduction of water ballast, and has a registered tonnage of 700 tons. The Messrs. Bowdler and Chaffer have had the steamer about four months on the stocks. The launch was very successful, with the exception of a slight hitch that occurred as the steamer fell over the wall and took the water. This was caused by the breaking of the cradle, and after a slight oscillation, the *West of England* recovered her position, and glided on amid the cheers of the spectators. We gather from the responses to the congratulatory toasts in the Mould loft, after the launch, that this vessel is fitted with a double bottom. Assuming that the material is properly disposed, we are prepared to congratulate those interested, in having gone so far towards building a seaworthy iron vessel. There is ample room for improvements yet to spare.

Raising of the Sunken Steamship "Ellen Sinclair."—A few weeks since the Ellen Sinclair, iron screw steamer, 665 tons register, came into collision, in the River off Erith, with the *Minna*, steamer from Oporto, and almost immediately went down. Her position was in the centre of mid-channel; at high water her topmast was just visible, while at the ebb her forecastle was just above water, which caused a great obstruction to the navigation of the river. The Thames Conservancy at once placed lighters near the sunken wreck, with green flags in the day and bright lights at night, to warn vessels of the danger, and gave notice to the owners of the wreck to take immediate steps to remove it. The Ellen Sinclair being insured, the underwriters undertook to do it. Divers were at once engaged to descend, and fixed chains under the bows and stern of the wreck—an operation which occupied several weeks to accomplish. In the meanwhile several vessels ran foul of the wreck, and carried away her rigging, and did other damage. Two Trinity ballast lighters also drove on the vessel; one broke up on it, and shot some 60 tons of ballast, with which she was laden, on the deck of the steamer. These disasters somewhat retarded the operations. They, however, were brought to a successful issue on the 31st March, when, by the aid of eight large chain lighters, the wreck was lifted from the spot where she had sunk, and carried close in on the Kent shore, where at low water she was partly dry, and there is every expectation that she will get afloat again, after the gap in her midships is filled up where the other steamer buried her bows at the time of the collision.

Magnesium for War Vessels.—It is now recommended that vessels of war should be built of magnesium, which is but little heavier than heart of oak, and as strong and tenacious as steel. It is estimated that the ocean itself contains 160,000 cubic miles of magnesium, a quantity which would cover the entire surface of the globe, both sea and land, to a thickness of more than eight feet. In obtaining salt from sea-water, the residuum is largely magnesium. The burning of a magnesium ship at sea would be a magnificent sight, a fire at which the stars "cold in their unimagined distances" might warm themselves.—*American Paper.*

A Self-Loading Ship.—M. De Coraux, a Lyonnese, has invented and constructed a ship which can load or unload itself automatically in 40 minutes. The captain and mechanician are the only living crew on board, the working and manipulation of the vessel and cargo being all performed by steam applied to most ingenious machinery. The loading is carried on by trucks and waggons, which can contain corn, flour, bales, cattle, horses, barrels, &c. The vessel is, as may be expected, of a peculiar disposition; but its exterior bears all the signs of sea-worthiness. The great revolution is on the deck and in the interior. The former is covered with lines of rail, reaching from one extremity to the other, while, at midships, there are two turntables. Front and rear are two or four immense cages, containing eight, twelve, or sixteen waggons, of the same size as our railway waggons. The rails on which the waggons rest are adapted exactly to the rails of the deck. A cable is hooked to the waggons, which traverse the deck throughout its length, and the stern of the boat having been previously placed on a level with the quay, which is also furnished with rails, or may be, perhaps, a portion of a terminus, the waggons glide without the least interruption from the vessel to the land, and *vice versâ.*

LAUNCHES.

Launches on the Clyde.—There was launched from the building yard of Messrs. Tod and M'Gregor, for the Liverpool trade, a fine screw steamer, which was named "Princess Alice." This vessel is intended to be a consort to the *Princess Royal.* The *Princess Alice* is 730 tons B.M., being 200ft. by 23ft. by 15½ft., with a pair of direct acting inverted cylinder engines of 150 horse-power, surface condenser, expansion valves, and all recent improvements, and will be fitted up in a style of completeness and efficiency similar to the *Princess Royal,* and have elegant accomodation for 40 to 50 first class passengers.

A beautiful iron paddle steamer was launched from Mr. Seath's shipbuilding yard, Rutherglen. Her dimensions are:—Length, 202ft.; breadth, 18ft; depth, 7ft. 6in. She will be fitted with engines of 110 horse-power. As she glided away, she was named the *Princess.* We understand that this vessel is intented for river passenger service.

Messrs. Aitken and Mansel, Whiteinch, launched a handsome screw steamer of 400 tons burden, named the *Scotia.* She is now being fitted with direct acting screw engines of 70 horse-power, by Messrs. James Aitkin and Co., Cranstonhill.

There was launched from the building yard of Messrs. Kirkpatrick and M'Intyre, Port Glasgow, a very handsome screw steamship, which was named the *Jacinth.* Her dimensions are 160ft. length, 24ft., breadth, 14ft. depth of hold, and 450 tons B.M. She will be supplied with a pair of direct acting engines of 60 horse-power. Twenty-seven years ago Mr. M'Arthur's late brother began the trade of carrying betwixt Glasgow and Liverpool. In 1838 five small vessels were purchased. The largest tonnage of these vessels was only 150 tons. Gradually the development of the trade compelled the firm to place larger vessels on the station, until twelve large traders are now employed.

TELEGRAPHIC ENGINEERING.

The New Atlantic Telegraph.—The preparations on board the *Great Eastern* for receiving the new Atlantic telegraph have been completed, and the important work of stowing away the cable in the tanks prepared for its reception, were commenced on the 14th March. The *Iris,* the hulk which was sent by the Government to the Telegraph Construction and Maintenance Company (Limited) for the purpose of bringing down the cable from the works at Mordan-wharf, East Greenwich, has arrived alongside the *Great Eastern,* with upwards of 200 miles of the new telegraph on board, and the work of winding it on board will continue without intermission till the whole is stowed away. At the end of June or the beginning of July, according to present arrangements, the *Great Eastern* will again commence her hazardous enterprise of laying the cable, which every one connected with the work is sanguine will this time be accomplished. The ship has behaved herself exceedingly well during her winter residence in Sheerness Harbour, and, notwithstanding that her immense broadside has been exposed to some of the heaviest gales ever known, it has never been necessary on any occasion to get up steam, as her anchorage has been quite sufficient for her security.

RAILWAYS.

A New Belgian Company has been formed under the denomination of "Société Belge de Chemins de Fer," the special object of which is to construct and work railways in Belgium and abroad. The first line to be constructed by this new company are eighty-five miles of railway in East and West Flanders. This line will be worked by the Société d'Exploitation.

The Newport section of the Breeon Merthyr and Newport Railway is opened for traffic, and in a short time the line is to be opened throughout from Newport to Merthyr and Brecon, completing the communication between the Brecon and Merthyr districts, and the railways travelling off to Shrewsbury, Crewe, Liverpool, and Manchester. This line was constructed by Mr. Savine.

The Great Luxembourg.—The working expenses of this single line are between 47 and 48 per cent. This rather large proportion was attributed by the chairman of their general meeting, to a general advance of wages and an increase in the price of fuel. He intimated also that both the line and the rolling stock were insufficient for the accommodation of the increasing traffic and the necessity for increasing their rolling stock, and doubling their line over that portion where the greatest traffic was expected. The opening of the Ourthe line would render the partial doubling of their line still more necessary.

Underground Railway in Bristol.—Surveys have been made for an underground railway in Bristol. The route to be taken is from Temple Meads to the Clifton Station of the Port and Pier Railway, and the subterranean line will be offered as a substitute for that for which Parliamentary powers have been obtained by the Port Extension Railway Company.

Progress of the North Somerset Railway.—The works of this railway are progressing with greater activity than has been the case for some time past. Several hundred men are now employed on different parts of the line. The Pensford Viaduct is, however, in a very backward state, owing to the few hands employed on it, and judging from the present rate of construction, it must take another twelvemonth before it is finished. The Deviation Bill, promoted by this company, and by means of which powers were sought to make certain deviations in the original line, was thrown out by the Committee of the House of Commons.

Heavy on the Railroads.—The late terrible war was heavy on the southern railroads. Every possible expedient was resorted to by our troops to effectually destroy, for use, the rails upon the roads which were torn up. Transportation beyond the reach of the enemy was impracticable, and any mere tearing up of the rails and road bed was soon repaired. Hence huge bonfires were made upon which the rails were piled to heat and twist them in such a manner they could not be again made serviceable, until taken to a rolling mill. Even to the present day, it is said that the quantities of rails so destroyed and still lying by the side of the tracks, is immense on the roads that were most frequently visited by the national troops. Along the Weldon (N. C.) railroad, thousands may yet be seen bent into right angles, and many completely coiled around the trees! Let us hope that the occasion for such a wholesale destruction of property will never again occur in our now peaceful land.—*American Paper.*

Melbourne and Hobson's Bay United Railway Company.—At a general meeting, held at Melbourne, a dividend at the rate of 10 per cent. per annum was declared, leaving a balance of £549.

The House of Lords has held that on the sale or winding-up of a bankrupt railway

company preferential shareholders lose their rights. As the public have hitherto supposed that the claims of preference shareholders extend to capital as well as to income—to assets as well as to dividends—it is well that it should be enlightened on such an important point.

Mitcham and Sutton Railway.—Much engineering talent has been fruitlessly expended in demonstrating the bad engineering on this line, reported by a "dreadful accident-maker" for the daily's, who, to intensify his miserable story, gave not only "chalk abutments," but also "a key-stone of native chalk." We considered the report so utterly extravagant, as to be beyond the pale of professional consideration. The South Coast Company are constructing a new line of railway, which is ultimately intended to connect their London terminus with Portsmouth, by a direct route. A portion of this line is known by the name of the Mitcham and Sutton Railway, which joins the existing Epsom line, on the London side of the Sutton Station. A deep cutting through chalk, about half a mile from the junction renders a bridge necessary for the public road. The work at this bridge was in active progress on the 29th of April when it suddenly fell and crushed six men. A coroner's inquest has since been held on the spot. No doubt the whole matter was well sifted during the six hours of sitting. There were present the legal representatives of the company, the contractor, the sub-contractor for the bridge, and of the men killed. Mr. H. C. Gough, C.E., described the construction of the bridge, being of one arch, and of 88ft. span, composed of brick, set in cement and mortar of blue lias lime, which was commenced in November, and finished in the following December of last year. During this time the weather was unfavourable, so that the centring was not completely taken down until the 18th of April. It was just possible that recent rains had softened the mortar. He could offer no better explanation of the cause of the fall. The materials and workmanship were good. A labourer said the mortar was bad, because the materials were not good, and he was not allowed sufficient time to make it. He had not been discharged. A brother-in-law of one of the men killed had worked at the bridge on the 27th, but left that job because the work was getting into "all manners of shapes." He got afraid to work there, but his fear did not warn his relative nor any one else. There was no keystone of chalk. The whole structure was brickwork, necessarily resting on a solid bed of chalk. The verdict of the jury, after a long deliberation on all the facts brought before them, was "accidental death on all the six men, caused by the giving way of the bridge."

The North Metropolitan Railway.—A new coal line from the Great Western to the Thames has been passed in the House of Commons. It will convey steam coal for shipment in the docks, and for use in the manufacturing districts in the east of London from South Wales, as well as all kinds of inland coal brought by the North Western, Midland, and Great Northern Railways. The line, which is about twenty-three miles in length, was practically unopposed, the Metropolitan Board of Works appearing only to watch the proceedings on behalf of public interests.

Presentation to the Engineer of the Hoylake Railway.—A very handsome testimonial has been presented by the heads of the several departments and others employed on the new Hoylake Railway, to Mr. C. M. Holland, the engineer of the line, previous to his departure for Spain. The testimonial consisted of a magnificent timepiece, surmounted by a bronze figure, with two beautiful bronze vases to match, the whole being supplied by Messrs. Penlington and Hutton, of the Crescent, Lord-street, Liverpool. The testimonial bore the following inscription:—"Presented to C. M. Holland, Esq., on the completion of the Hoylake Railway, as a recognition of his services and as a mark of esteem from the workmen employed on the railway."

Extension of the Hoylake Railway.—At a special general meeting of shareholders in the Hoylake Company, the secretary read the heads and marginal notes of a bill now passing through Parliament—having passed the Commons—for the extension of the line to Parkgate, and for other purposes; also a bill for the extension of the Wrexham, Mold, and Connabs Quay Railway, by tunnelling under the Dee, to Neston, and for other purposes. Resolutions, approving of both bills, were passed. It was stated that the line from Hoylake to Wallasey Bridge station, at Wallasey Pool, will be opened on the 1st of June. Negociations are pending with a well-known omnibus proprietor for carrying the traffic from the present terminus to Woodside Ferry, a distance of about three miles, the arrangements with regard to continuing the Birkenhead street railway, so as to meet the Hoylake line, having fallen through.

DOCKS, HARBOURS, BRIDGES.

The Harbour Works, Holyhead.—These works are fast drawing to a completion. The only work of any considerable extent still unfinished, is the lighthouse at the farthest end of the breakwater. Though commenced years ago and worked with great engineering skill and energy, it has not yet reached low water mark. The divers have, up to the present, only laid the foundation. Considerable interest was felt by the officials and workmen of the harbour in the "inauguration" of a monster crane—a "Samson"—principally the invention of Mr. W. Williams, Messrs. J. and C. Rigby's foreman of works. The contractors had afforded Mr. Williams every facility in the construction of this ingenious mechanism, by which a stone of twenty tons can be lifted, moved, and conveyed from the breakwater to a distance of 180ft., and then deposited in less than five minutes with the assistance of two men only. Prior to this, six men were required to work at the crane, and the erection of the lighthouse was somewhat retarded, which will, no doubt, be compensated for by this contrivance. The inventor, Mr. W. Williams, received the congratulation of those who witnessed the first highly successful action of the "Samson." Though a monster contrivance of 72ft. in length, 18ft. in breadth, and worked by an engine of 7 horse power, it is exceedingly simple and reflects much credit on Messrs. Rigby and their foreman.

MINES, METALLURGY, &c.

Colliery Explosions.—There is a movement a-foot among the colliers to obtain a legal enactment, that coroner's juries on accidents in mines, shall be composed of one half practical miners, to ensure jurors who can appreciate the evidence adduced. Such is the result of dissatisfaction felt at Wigan with the verdict of the coroner's jury on the occasion of the late colliery explosion at Park-lane, by which thirty persons lost their lives. There appears to be £1,800 in the hands of the Government inspector of mines for the district, forwarded from the surplus of the Hartley explosion fund, which is intended to be the nucleus of a general fund for the relief of distress caused by colliery accidents in the district. The widows by the Park-lane explosion are allowed 5s. a week whilst unmarried, and 1s. for each child.

Nova Scotia Mines.—The Chief Commissioner of Mines has presented his report for the financial year ending 30th September, 1865. Royalty was paid in the year upon 24,867ozs. of gold, an increase of 6,123ozs. over the previous year. About 700 miners were at work throughout the year upon an average, and calculating the gold at only 18dols. 50c. per oz., which is below its market value, the average yield per man was about 2dols. 10c. per working day. The result of the coal mining of the year was also very satisfactory. The total quantity of round and slack coal sold from the mines amounted to 652,854 tons, an increase of 30 per cent. over the previous year. 59,636 tons were used for home consumption, 52,561 tons were exported to neighbouring colonies, and 540,757 tons to other countries, principally the United States. There are now thirty collieries at work in Nova Scotia. The iron mines are comparatively unimportant as yet, but about 1,500 tons of bar iron were shipped to England.

Mineral Resources of the Western States and Territories.—The following table shows the area of each of the twelve Western border states and territories of America, in square miles, and the extent of the mining districts of the same, in statute acres:—

State or Territory.	Total Area in sq. miles.	Extent of Mining Districts. Acres.	State or Territory.	Total Area in sq. miles.	Extent of Mining Districts. cres.
			Brought forw.	740,898	475,338,900
California	158,685	101,658,680	Utah	106,382	68,074,480
Dacotah.........	148,832	95,316,480	Oregon	84,248	60,958,720
Nevada	81,539	52,184,960	Idaho	326,375	208.878,726
Colorada	104,500	66,880,000	Nebraska	75,955	44,796.160
New Mexico...	121,201	78,568,640	Washington ...	66,994	48,636,800
Arizoua	126,141	80,730,140	Kansas	81,318	53,043,550
Carried forwd.	740,898	475,338,900	Total.........	1,495,310	957,720,400

Of this total acreage, no less than 61,938,546 acres have been disposed of. The territory of Idaho alone has five times the extent of Pennsylvania.

The China Steam Ship and Labuan Coal Company.—The report of this company stated that the company have obtained large concessions of land, and an additional right for raising petroleum, cutting timber, &c. Their coal takes a good place in the markets of China and Singapore. Springs of oil have been discovered in three districts. They consider a tramway is necessary to bring down their coal, and the Government has granted 650 acres of land per mile of tramway. They estimate the cost of the proposed line at £27,000. All who know anything of their coal have been looking forward to its improvement, as they got into deeper workings. The superficial coal ought not to have been sent into the market, to compete with English coal. It earned for the Labuan coal a character which will involve much time to remove to establish confidence. Had they been in less haste to rush into the market they would now be in a better position. Some companies are blest with agents who are too clever, or directors who are too cunning; to whom coals are coals, nor more, nor less. Of course coals are raised for profit and not for pleasure. The only profit which a superficial coal can yield, is a bad name; which experience it would have been better to avoid.

BOILER EXPLOSIONS.

Boiler Explosion near Swansea.—A terrific explosion of a steam-boiler occurred in the night of April 4-5 at the Cwmfelin Tinworks, near Swansea. Five of the unfortunate workpeople were killed, and four others badly injured. The Cwmfelin works are owned by Mr. David Davies, and give employment to three hundred men; and as the machinery is much damaged, the works are brought to a complete standstill. The money sacrifice—irrespective of the loss of life—is estimated at £2,500. The shocking catastrophe has spread a mournful gloom over the neighbourhood. Another account states that, besides the four killed, nine more are seriously injured, and several others burnt and scalded. The works are a complete wreck, the roof being completely blown away and the walls thrown down. Such was the force of the explosion that the boiler, weighing about 13 tons, was carried some 40ft. from its original position.

APPLIED CHEMISTRY.

Oxidation of Vegetale Oil.—In a memoir upon this subject, read to the Academy of Sciences of Paris, M. Cloez announces the following results of his experiments and observations:—1. That all the fat oils absorb oxygen from the air, and increase in weight by quantities which differ, for different kinds of oil placed under the same circumstances, and for the same oil under different circumstances. 2. That the height of the temperature exercises a very marked influence on the rapidity of the oxidation. 3. That the intensity of the light also manifestly influences the phenomena. 4. That light transmitted by coloured glasses checks more or less the resinification of the oils by the air. Starting from colourless glass as the term of comparison, the decrease of oxidation is in the following order: colourless, blue, violet, red green, yellow. 5. That in darkness the oxidation is considerably retarded; starts later and progresses more slowly than in light. 6. That the pressure of certain materials, and the contact with certain substances, accelerate or retard this effect. 7. That in the resinification of oils there is both a loss of carbon and hydrogen of oil, and an absorption of oxygen. 8. That the different oils, in oxidising furnish in general the same products; volatile acid compounds, liquid and solid fat acids not altered, and an insoluble solid material which appears to be a definite proximate principle. Oils oxidised in the air no longer contain glycerine. 9. The drying and non-drying oils are not chemically distinguishable. All contain the same glycerine proximate principles, but in different proportions.

Wood in Paper.—To detect wood in paper, Herr Schachgringer, of Vienna, uses sulphate of aniline, to a few drops of sulphuric acid with a little water, and warms the whole over a spirit-lamp. This done, he dips into it a small piece of the paper to be tested. A citron-yellow colour is produced, which is the more intense in proportion to the quantity of wood in the paper.

Calico Printing.—This branch of industry is the art of producing figured patterns upon calico by means of dyes and mordants topically applied by wooden blocks, copper plates, &c., by which the goods are either printed in colours, or receive their pattern, by being run through a colouring bath or mordant, when the dye is only produced upon that portion of the ground previously prepared for it. Of late this system has been extended to silk and woolen fabrics. The mordants are thickened with some glutinous substances, such as flour, starch or gum, to render them adhesive and prevent their spreading. There are eight styles of calico printing, each one requiring a different manipulation. 1st. The padding style in which the white cloth is passed through a bath of some particular mordants, and different mordants are afterwards printed on it before submitting it to the dyeing bath. By this means the colour of the ground and pattern is varied. 2nd. The reserved style in which white or coloured spots are produced on a blue ground, by covering those parts with a composition called resist paste, before passing the goods through the dye bath. 3rd. The discharge or reagent style is the contrary of the preceding. It shows bright figures on a dark ground and is produced by printing with discharge mordants before the fabric is passed through the dyeing bath. 4th, The china blue resembling the colour of blue stone ware. 5th. The decolouring style, in which chlorine or chromic acid is topically applied to the surface of the goods previously dyed, by which the colour is discharged. 6th. The madder style, in which the mordants are applied to the white cloth and the colours are brought out in the dye bath. 7th. The steam colour printing consists in printing the calico with a mixture of dye extracts and mordants, afterwards exposing it to the action of steam. 8th. Spirit colour printing is a method by which brilliant colours are produced through a mixture of dye extracts and solution of tin, called by the dyers "spirits of tin."

Some French Chemists have succeeded in obtaining oxalic acid from the waste of shoemakers' and saddlers' shops, and others where leather is used; also from woollen rags, horn, hair, &c. For this purpose these residues are treated with one part of sulphuric acid and four of water, and the mass thus obtained is subjected to the action of one part of nitric acid and three of water, at a temperature of about 80° Cent. From the digestion of this oxalic acid is easily extracted.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF THE ARTIZAN."

DATED APRIL 21st, 1866.

1130 W. E. Newton—Expressing liquids from pulpy and semi-fluid substances
1131 J. G. Taylor—Dress fastenings and ornaments
1132 F. C. Buisson—Treating and applying a substitute for the tobacco plant
1133 H. A. Coustesaux—New method of advertising
1134 J. H. Wilson—Distillation of sea water on board ships
1135 J. Baker—Thermo-electric batteries
1136 G. E. Donisthorpe—Getting coal and other minerals
1137 J. Player—Hot blast stoves
1138 G. E. Donisthorpe—Machinery for washing wool

DATED APRIL 23rd, 1866.

1139 M. Spiquel and E. H. Florange—Stamping on flatted or unflatted metals
1140 M. Spiquel and E. H. Florange—Rendering concavo-convex metals either in a flatted or unflatted state
1141 F. Barnett—Aquatic firework
1142 H. A. Huzzey—Ejecting water from the holds of steam ships or other vessels
1143 J. W. Butler—Aerostatic apparatus
1144 H. T. Wedlake—Construction of harmoniums
1145 J. Pumphrey—Portable irrigator for watering gardens
1146 E. H. Huch and F. J. Windhausen—Engines worked by steam
1147 R. W. Abbotts—Improvements in the fire-places or furnaces of malt and other kilns
1148 C. D. Abel—Rippling or seeding flax
1149 C. D. Abel—Machinery for breaking and scutching flax and hemp
1150 H. D. Plimsoll—Application of materials to surfaces for ornamental purposes

DATED APRIL 24th, 1866.

1151 J. M. Ryo-Catteau—Spindles applicable to all machines for spinning and doubling cotton
1152 R. Thompson—Machinery for veneering mouldings
1153 R. Stackhouse—Improvements in charts
1154 S. Thompson—Construction of pianofortes
1155 E. Burles—System of working, permitting to obtain with facility from all kinds of fabrics a great number of designs
1156 G. F. Russell and W. H. Carbines—Manufacture of gas
1157 C. D. Abel—Joints for pipes

DATED APRIL 25th, 1866.

1158 A. A. L. P. Cochrane—Heating and evaporating liquids
1159 D. Bievery—Furnace for the cooling of window glass
1160 J. W. Burton—Mode of treating animal fibrous substances
1161 J. S. Crosland—Improvements in steam engines
1162 A. Upward and A. A. Cochrane—Manufacture of gas
1163 G. E. Noone—Machinery for treating sewage
1164 W. Clark—Machinery for making twist drills
1165 W. E. Gedge—Spring bed or mattress
1166 H. C. Butcher—Piercing and holding cigars
1167 A. Borgnet—Improvements in furnaces

DATED APRIL 26th, 1866.

1168 H. A. Bonneville—Crinoline skirts
1169 H. A. Bonneville—Spring mattresses
1170 T. Kirby—Machinery for raising and lowering revolving shutters
1171 S. Sequelin—Preparation of animal and vegetable wax
1172 H. Gardner—Hooks to suspend curtains
1173 W. Edmond and A. Gurlt—Furnaces and apparatus for separating heated gases
1174 A. Paraf—Printing and dyeing textile fabrics
1175 J. Curtis—Draining and consolidating cuttings of railways
1176 A. Paraf—Printing and finishing all materials where ultramine colours are used
1177 G. Haseltine—Uniting mineral and metallic substances with vegetable fibres and fabrics
1178 G. H. Cottam and H. R. Cottam—Iron bedsteads
1179 C. Hedler—Photographic pictures

DATED APRIL 27th, 1866.

1180 T. W. Tobin—Solution of lime for softening hard water
1181 T. Marshall—Supplying water to steam boilers
1182 E. Holden—Ventilation of rooms
1183 J. Strang—Cop tubes and shuttle skewers
1184 J. Taylor—Increasing the expansive power of steam and other elastic fluids
1185 F. A. Renault—Power loom knitters
1186 M. Nelson—Making impressions for stereotype or electrotype plates
1187 W. Soper—Mounting targets for rifle ranges
1188 J. Wavish—Improvements in gas lamps subject to the exposure of high winds
1189 P. Sauderson—Manufacture of yarns
1190 D. B. White—Ventilators for windows
1191 T. Deakin—Moulding toothed or other wheels for casting
1192 J. Howard and E. T. Bousfield—Working steam tilling implements
1193 J. W. Hoffmann—Improvements in fountains
1194 T. Dixcee—Moulding clay or other plastic material into bricks
1195 J. B. Thompson—Protecting iron ships from fouling and corrosions
1196 T. A. Weston—Ratchet braces and levers
1197 E. Bray and J. C. Hargreaves—Prevention of steam boiler explosions

DATED APRIL 28th, 1866.

1198 G. Burnard and L. Koppel—Preserving milk and cream
1199 J. L. Davies—Looms for weaving
1200 D. Thomson—Steam boilers
1201 J. B. Robertson—Sewing machines
1202 D. R. Edgeworth—New surveying instrument
1203 T. Hutton—Improvements in casks
1204 W. Sunderland and G. Stell—Spinning machinery
1205 J. W. Hoffmann—Improvements in churns
1206 H. E. Newton—Engines for obtaining rotary motion by means of steam
1207 A. V. Newton—Manufacture of steel
1208 E. J. Beard—Construction of fastening for baling bands
1209 W. P. Piggott—Preventing corrosion and fouling of iron ships
1210 W. Begg—Arrangement of furnaces for facilitating the combustion of smoke
1211 C. A. B. Target—Balancing and raising or lowering window sashes
1212 J. C. Pesrce—Steam engines and boilers

DATED APRIL 30th, 1866.

1213 R. R. Riches and C. J. Watts—Feeding apparatus applicable to mills and machines for grinding or crushing grain
1214 A. Bernard—Decoloration of albumine extracted from the blood of animals—red blood
1215 G. Davies—Improvements in carriages
1216 W. J. Murphy—Apparatus for propelling ships
1217 J. Barou and E. Tattersall—Improvements in carding engines
1218 F. Jenkin—Apparatus for winding in telegraphic cables
1219 C. D. Fox—Screw cutting and threading machines
1220 J. H. Johnson—Musical instruments
1221 W. Deakin and J. B. Johnson—Manufacture of hollow projectiles

DATED MAY 1st, 1866.

1222 H. Lea—Looms for weaving
1223 C. D. Abel—Apparatus for reducing metallic oxides
1224 J. Nisbet—Apparatus for getting or cutting minerals
1225 J. Spencer and D. McCorkindale—Rolling mills
1226 G. Davies—Insulators for telegraph wires
1227 G. Davies—Steam boilers
1228 J. V. Delestie—Trap for destroying flies and other insects
1229 R. H. Hughes—Improvements in lamps
1230 J. Lewis—Valves used in regulating the flow of steam
1231 O. R. Chase—Manufacture of confectionery
1232 J. Thomas—Reverberatory blast furnaces for smelting ores
1233 G. C. Denis—Refrigeratory safety washer
1234 J. Jackson—Night lights
1235 F. Gritton—Treating malt

DATED MAY 2nd, 1866.

1236 F. F. Benvenuto—Feeding holder applicable to writing and drawing pens
1237 H. Moore, T. Sugar, G. Keighley, and T. Richmond—Looms for weaving
1238 J. Morris—Mills for grinding wheat
1239 D. Cohen—Dry gas meters
1240 G. Davies—Heating the boilers of locomotive steam engines
1241 J. Shorrock and G. Shorrock—Pickers for looms
1242 W. Cormack—Calcining animal and vegetable coal
1243 J. R. Towers, T. Clutterbuck, and J. B. Muschamp—Pocket for male and female attire
1244 A. A. Costallat—Artificial flowers
1245 W. Ince and W. H. Bedwell—Improvement in umbrellas
1246 W. H. Stanley—Cricket wickets
1247 C. H. Ramsten—Apparatus used when lowering and releasing ships' boats
1248 W. De la Rue—Manufacture of steel and iron
1249 C. Nurse—Harness and Saddlery
1250 R. Brierley—Improvements in carts
1251 G. Feasey—Composition for removing incrustation in steam boilers
1252 D. Urquhart—Furnaces for economising the fuel employed for warming buildings
1253 J. Botterill—Apparatus for consuming smoke

DATED MAY 3rd, 1866.

1254 H. A. Manfield—Pickling vegetables
1255 C. W. Harrison—Obtaining copper and other metals from their ores
1256 P. Spence—Separation of certain metals from their ores
1257 S. Bourne—Treating india rubber
1258 J. W. Post and W. M. Cranston—Scrapers for cleaning gun barrels
1259 G. T. Bousfield—Manufacture of yarns from wool

DATED MAY 4th, 1866.

1260 E. Field—Attaching buttons to leather
1261 J. G. Hope—Composition for destroying vermin on sheep and other animals
1262 F. Furrell—Fixing rowlocks to all descriptions of boats
1263 A. T. Becks—Manufacture of iron
1264 H. Douglas and J. Douglas—Making cop tubes
1265 C. E. Brooman—Improvement in combs
1266 A. Morel—Treatment of filamentous materials
1267 W. E. Gedge—Improvements in railway rolling stock
1268 R. Darragh—Improvements in shuttles
1269 T. Blezard, J. Blezard, J. Blezard, and N. Blezard—Self-acting temples for looms for weaving
1270 W. B. Bartram—Sewing machines
1271 C. de Cæsaris—Preparing hides and skins for tanning
1272 J. Bupty and F. North—Machinery for preparing wool
1273 J. Walker and A. Warner—Compressing cotton upon trucks upon railways
1274 J. G. Hope—Composition for destroying vermin on sheep and other animals
1275 J. H. Johnson—Apparatus for lacing boots and shoes
1276 A. Roders—Felt carpets
1277 G. T. Bousfield—Machinery for converting reciprocating into rotary motion
1278 W. Young and P. Brash—Distillation of coal
1279 G. T. Bousfield—Steps for the spindles of spinning frames

DATED MAY 5th, 1866.

1280 W. H. Crispin—Steam roller for agricultural purposes
1281 J. Marsh—Lubricating the spindles employed in machinery for spinning
1282 G. Davies—Exhausting and compressing air
1283 C. E. Brooman—Machinery for combing
1284 C. E. Brooman—Drawing and propelling boats
1285 T. D. Rock—Stands for telescopes
1286 A. L. Bricknell—Apparatus applicable as a rotary engine pump and water meter
1287 J. L. Booth—Railroad rails
1288 J. H. Johnson—Machinery for washing wool
1289 H. Statham and B. Collins—Improvements in carriage springs
1290 J. Hartshorn—Method of producing mattings
1291 H. K. York—Manufacture of iron and steel
1292 S. Clutwood and J. Storgeon—Cupola and other furnaces

DATED MAY 7th, 1866.

1293 J. Milner—Expansion gear of steam engines
1294 V. de Tivoli—Partial or total baths for man or animals
1295 V. de Tivoli—Application of pads of india rubber
1296 F. Waddington—Machine to clean up and prepare cotton fabrics
1297 A. Pucheron—Manufacture of glass
1298 D. Chadwick and G. A. C. Bremme—Dressing fibres
1299 E. Fidler—Machinery for holeing and drilling coal
1300 W. W. Cross—Working the extractors for central fire guns
1301 W. Clark—Lighting apparatus
1302 T. Green—Steam boilers
1303 J. Brown—Machinery for actuating railway signals and points

DATED MAY 8th, 1866.

1304 M. H. Atkinson—Valves for steam and other engines
1305 C. Moseley—Machinery used in the manufacture of sheets of india rubber
1306 B. Wright—Kitchen ranges
1307 G. Seeley—Penholders
1308 W. Ireland—Draining or drying steam previous to its employment for working steam engines
1309 W. E. Gedge—Combination of apparatus fitting within every sort of chimney and preventing any smoke being driven back into apartments
1310 W. E. Gedge—Clarifying apparatus
1311 J. H. Johnson—Apparatus for propelling and steering ships
1312 F. Wise—Axle boxes and bearings for the journals of railway carriages
1313 J. Becker—Method for packing up bottles
1314 G. Snowball—Watch pendants
1315 W. B. Woodbury—Producing designs upon wood
1316 W. McIlwraith—Coating wagon covers
1317 J. R. Swann—Improvements in lime kilns
1318 G. T. Bousfield—Cordage webbing
1319 J. Crawford—Abdominal supporters
1320 J. L. Norton and A. Giles—Evaporating volatile and combustible liquid to obtain light or heat therefrom
1321 D. Gautier and A. Domeier—Supporting and extending the skirts of ladies' dresses
1322 J. H. Ritchie—Attaching wooding planking to iron ships
1323 M. Henry—Sewing machines
1324 S. A. Bell—Manufacture of tapers and of friction matches

DATED MAY 9th, 1866.

1325 J. Fletcher—Machines for cutting, rolling, and shearing bars of metal
1326 J. H. Johnson—Apparatus for drying and cooling grain
1327 J. A. Jones—Non-conducting substances
1328 W. E. Gedge—Method for preserving the banks of rivers
1329 J. Sheldon—Improvements in water pressure regulators
1330 S. Middleton—Means of securing and discharging the contents of pipes and vessels
1331 H. Essex—Sewing needles
1332 R. Rowland—Manufacture of metallic acetates and carbonates
1333 W. E. Newton—Rotary blowers
1334 D. C. Dallas—Production of printing and other surfaces in relief or intaglio

DATED MAY 10th, 1866.

1335 D. Sowden and R. C. Stephenson—Looms for weaving
1336 G. Ashworth and E. Ashworth—Mechanism for turning over leaves
1337 W. Hackett and W. Marsden—Construction of water closets
1338 O. Brothers—Regulating and controlling the pressure and flow of illuminating gas
1339 J. Cole and G. S. Melland—Extracting cartridge cases from breech-loading firearms
1340 R. Holliday—Obtaining green colouring matters of various shades for dyeing and printing
1341 J. H. A. Bleckmann—Explosive compound
1342 J. White—Hair felt
1343 L. R. Bodmer—Double cylinder carding engines
1344 J. L. Rickards—Improvements in candlesticks
1345 W. Botwood—Improvements in carriages
1346 J. Bernard—Elevating and forcing water
1347 T. Thornton—Raising and lowering ships' boats
1348 A. V. Newton—Manufacturing illuminating gas
1349 D. Nicoll—Preserving animal and vegetable substances from decomposition

DATED MAY 11th, 1866.

1350 W. Prosser—Treating metals
1351 W. Austin—Joining pipes and tubes
1352 J. M. Hart—Connecting knobs and their spindles to locks and latches
1353 W. C. Moore, J. M. Haslam, and J. Robinson—Machinery for preparing cotton
1354 T. Wimpenny—Furnaces employed in generating steam
1355 W. Weldon—Production of sulphide of sodium
1356 J. Craig—Securing door handles
1357 H. Fraser—Corking bottles
1358 B. Nicoll—Economical construction of buildings
1359 E. Braiser—Machinery for scutching and preparing flax
1360 W. Clark—Shoes and other furniture for the protection of the feet and ankles of horses and other animals
1361 T. Hunt—Breech-loading firearms

DATED MAY 12th, 1866.

1362 W. Harrison, J. Harrison, and H. Harrison—Hammering cylinders
1363 T. J. Chapman and T. Rose—Construction of water-closets
1364 W. H. Southwell, F. Southwell, and E. Southwell—Photographic prints
1365 A. P. Price—Improvements in the combustion of fuel
1366 G. A. Jasper—Process of cleansing animal black or bone charcoal
1367 C. Pryse and R. Redman—Breech-loading firearms
1368 W. Dennis—Casks and taps for drawing liquids therefrom

DATED MAY 14th, 1866.

1369 R. B. Pope—Governing apparatus
1370 R. Fyers—Construction of umbrellas and parasols
1371 J. Webster—Hoeing, raking, and rolling gravel walks by one machine and at one operation
1372 W. Gerard—Fittings applicable to ships' decks
1373 G. H. Bovill—Mode of applying sewage to land
1374 W. E. Newton—Metallic barrels and other vessels containing oil and other fluids
1375 T. Holt—Construction of steam boilers
1376 J. H. Johnson—Self-acting fire alarms

DATED MAY 15th, 1866.

1377 J. E. Phillips—Axles for railway and other carriages
1378 H. Grafton—Gun locks
1379 G. Haseltine—Centrifugal governors
1380 J. Cheverton—Obtaining surfaces for printing from stereotyping and electrotyping
1381 W. De la Rue and H. Muller—Treating the residues of pyrites
1382 W. Payton—Construction of dry gas meters
1383 H. Muller and W. De la Rue—Treating printers' rags
1384 G. Haseltine—Mode of and means for promoting ventilation
1385 B. G. Nichol—Construction of rotary engines to be worked by steam or other power

DATED MAY 16th, 1866.

1386 A. Cochrane—Fastening covers or cushions to chairs
1387 J. S. Gisborne—Thief and fire-proof safes
1388 F. Field—Manufacture of candles
1389 W. Curry—Manufacture of bricks
1390 E. Price and C. Price—Improvements in safes
1391 J. W. Bartlett—Sewing machines
1392 G. A. Elliott—Opening and closing railway carriage and other windows
1393 C. Aggio, F. Cotti, and N. Ferrario—Preserving and saving life and property at sea in case of shipwreck
1394 W. Clark—Lamps for burning mineral and other oils
1395 W. Clark—Improvements in furnaces and other fire-places
1396 W. E. Newton—Breech-loading firearms

DATED MAY 17th, 1866.

1397 G. Macdonald—Machinery for cleaning and ginning cotton
1398 J. Hampton—Furnaces for obtaining perfect combustion of fuel
1399 T. H. P. Dennis—Improvements in green-houses
1400 C. Chapman—Improvements in the rig of ships
1401 J. Bernard—Improvements in motive power engines
1402 J. Besle—Improved rotary engine to be used for pumping fluids or gases
1403 J. Thomas and A. Prince—Treating scoria or slag of copper ores
1404 W. E. Newton—Measuring the depth of water

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TABLES OF EQUIVALENTS AND THEIR LOGARITHMS FOR THE CONVERSION OF MEASURES AND WEIGHTS OF VARIOUS COUNTRIES.

By Joseph T. Dann.

These tables comprise the bases of the longitudinal, square and solid measures and the weights of the most important countries of Europe and America, and are designed with a view to facilitate the conversion of the latter among themselves, either by a direct arithmetical operation or by logarithmic calculation; a list of "multiples and subdivisions" is appended to the tables for the purpose of serving as a guidance in similar operations with aliquot parts of the denominations given in the tables themselves.

To explain the mode of using these tables, no lengthy directions are requisite. Each of the eight tables contains ten different kinds of measure, arranged according to their relative magnitude, the largest measure of each kind occupying the first column, the smallest the last. To convert a measure or weight of any one country into the corresponding one of any other country recorded in these tables, take the unit (1) in that column containing the kind of measure to be converted, and the square which forms the intersection between the *row* containing this unit and the *column* containing the kind of measure sought for, will give the respective equivalent in black figures, and the logarithm of the same in light ones.

Example 1.—Wanted the value of 1 English foot in French mètres (Table I).

Take 1 in the sixth square of the column headed "English foot," pass your finger to the left along the row up to the first column, headed "French metre," and the square on which you alight contains the number you want, with its logarithm, that is to say:

1 English foot = ·304794 metre.
log. ·304794 = ·4840064—1

Example 2.—Wanted the equivalent of a Prussian pound in Swedish pounds (Table VII.)

Take 1 in the fourth square of the column headed "Prussian pound," pass your finger to the right along the row till you reach the eighth column, headed "Swedish pound," and you find in the corresonding square, that

1 Prussian pound = 1·099598 Swedish pound.
log. 1·099598 = ·0412341.

It is only in the French metric system and those derived from the same, that *all* the weights and measures are based upon a uniform standard, viz., a certain length called the *mètre*, being 1-10,000,000th part of the earth's quadrant. The number 10 which forms the base of our system of cyphering (the Arabic figures) is used throughout all the multiples and subdivisions of the mètre; thus:—

1 mètre = 10 decimètres = 100 centimètres = 1,000 millimètres.
1 kilomètre = 1,000 mètres.
1 sq. mètre = 10,000 sq. centimètres.
1 cubic mètre = 1,000 cubic decimètres = 1,000,000 cubic centimètres.
1 hectare = 100 ares = 10,000 sq. mètres.
1 sq. kilomètre = 100 hectares.
1 kilogramme = the weight of 1 cubic décimètre of distilled water.
1 litre = the capacity of 1 cubic décimètre.

This system, invented and first introduced during the time of the first French revolution, has been made compulsory in France by law of July 4th, 1837. Ever since it was first proposed, it has found many adherents and many adversaries. It has been most effectually advocated and patronised by the International Decimal Association, but has had to contend with strenuous opposition in most countries, whenever its introduction was attempted. Its defects and shortcomings have been pointed out and exposed by Mr. Nystrom, in the "Tonal system" (Philadelphia, Lippincott, 1862), and he, in his turn, proposes to substitute, under this name, a binary system, with the base 16, for the bases 10 and 12 of the decimal and duodicimal systems respectively.* Still, to judge from the effect, it appears that the intrinsic merits of the metric system outweigh the numerous and serious drawbacks under which it labours, and the duodecimal and mixed systems can no longer hold their own in international intercourse. The French system has been successfully adopted, *pur et simple*, in Belgium, the Netherlands, Italy, the Iberian Peninsula, Greece, and Roumania; and with modifications of greater or less extent, in Denmark, Switzerland, and various States of Germany.† An Act of Parliament to render permissive its use in commercial and industrial transactions has been in force in this country for some time past; and a Bill to the same effect has recently been introduced in the United States Congress.

On the other hand, the duodecimal standards are anything but extinct even in those countries in which they have been repealed by legal enactment. Even in France the common use of the former denominations, though made penal by statute, has remained in force in the shop and the market, and in everyday life the foot, pound, and league have not yet given way to the mètre, kilogramme, and kilemètre. The same is the case in Belgium and Holland, and to a still greater extent in all other States that have adopted the metric system. Many years may elapse before the original weights and measures become obsolete in those countries; and certainly it is not to be expected that in our time the system at present in use will be supplanted by the metric one in England and the United States.

The eight tables given will be found sufficient for all engineering and other industrial, as well as for the statistical purposes for which they are designed. It will often be requisite to resort to the explanatory list of multiples and subdivisions appended to them, in order to ascertain the equivalents in conformity with standards heading each respective column. As in complicated calculations it will frequently be thought desirable to use logarithms (especially if the numbers need not have more than five or six places), each equivalent has the corresponding logarithm appended to it. Most of the equivalents have been computed from the logarithms carefully compiled from Hutton's and Vega's tables; and as neither of the latter goes beyond the limit of 108,000, it should be remarked that in the equivalents the first five figures only (*i.e.* five decimals in one and mostly four decimals in the other half of each of the eight tables), can be considered absolutely exact, the remainder being but approximate. Thus, each equivalent is calculated to

6 decimals, if the mantissa of its logarithm is	0, 1, 2, or	— 1
7 „	„	„	„	— 2
8 „	„	„	„	— 3

The logarithms themselves are all computed with the utmost attainable exactitude, and each of them with 7 decimals.

The following examples will shew the great advantage of working problems of conversion by means of the logarithms given in these tables, instead of proceeding arithmetically.

* It is obviously out of the question to realise, to any extent whatever, an idea that might have its merits, if it were not designed to supplant anything else; whereas, in fact, the decimal system of ciphering at present in use is as old as the world.

† The most important modifications are:—the pound of 500 grammes in Denmark, Switzerland, and the whole of the Zollverein; the foot of 30 centimètres in Switzerland and Baden, and of 25 centimètres in the Grand Duchy of Hesse.

(Table 1.)

Example 3.—Wanted the equivalent of 224 klafter 4ft. 6in. (Austrian) in English measure.

1 klafter = 6ft. 224 klafter = 1344 ft.
+ 4·6
1348·6 Aust. ft.

1 Austrian foot = 1·037426 (as per table).
log. 1348·6 = 3·1298832
+ log. 1·037426 = ·0159572 (as per table).
3·1458404 = log. 1399·04
12
·48

i.e.—224 klafter 4ft. 6in. (Austrian) = 1399ft. ·48in.; or 466yds. 1ft. ·48in.

(Table 2.)

Example 4.—424·26 statute miles = ? German miles.

1 statute mile = ·217258 German mile (as per table).
log. ·217258 = ·3369749—1 (as per table).
+ log. 424·26 = 2·6276321
1·9646070 = log. 92·1737.

i.e.—424·26 statute miles = 92·1737 German miles.

(Tables 5 and 6.)

Example 5.—The population of France, according to the census of 1861, was 37,382,225 souls on a total area of 543,051·41 square kilomètres. To what density, or average population per statute square mile, and per statute acre does this correspond?

1 square kilomètre = ·386116 statute sq. mile (as per table.)
log. ·386116 = ·5867178—1 (as per table).
+ log. 543,051·41 = 5·7348409
5·3215587 = log. 209,680·82 sq. miles.

i.e.—543,051·41 sq. kilom. = 209,680·82 statute sq. miles.
× 640 = 134,195,724·8 acres.

Divide the population by number of square miles, or subtract respective logarithms from each other, *i.e.*

log. 37,382,225 = 7·5726649
— log. 209,680·82 = 5·3215587
2·2511062 = log. 178·2815.

i.e.—the density of the population of France will be = 178·2815 souls on each statute square mile, or 0·27856 per statute acre.

These examples are, no doubt, sufficient to show how to use these tables with advantage.

To ascertain the standards and bases from which the equivalents were computed, and the multiples and subdivisions comprised in the appendix, were compiled, the following works have been consulted:

1. *C. H. Dowling*, "*A Series of Metric Tables.*" (London: Lockwood and Co., 1864.)

This excellent work contains 72 comparative tables for the conversion of metric into British weights and measures and *vice versâ*: the quotients for our French standards are taken from the introduction to this compilation.

2. *Annuaire pour l'an* 1866, *publié par le Bureau des Longitudes.* (Paris: Mallet-Bachelier, 1866;) and

3. *A. Quetelet, Almanach Séculaire de l'Observatoire Royal de Bruxelles.* (Brussels, 1854.)

Of the former, the Tables for the conversion of old French into metric, and of the latter those for the conversion of Rhenish into Metric Measures and *vice versâ* have been utilised.

4. *Ed. Blache* (Vice-Consul of France at Belfast), *Guide du Capitaine sur les Côtes de la Grande Brétagne, avec un Indicateur universel des monnaies, poids et mesures.* (Paris, Guillaumin, 1862).

The modest appendix to this work contains a very large quantity of most useful information on all old and new weights, measures, and coins; it is the most extensive compilation of this kind, and in many respects superior to Nelkenbrecher's "Taschenbuch" which is of a similar character, but mostly confined to German data.

5. *Redtenbacher, Resultate für den Maschinenbau.* (Mannheim, Bassermann, 1856).

The standards for all German weights and measures are to be found in the "Collection of Tables" appended to this work.

6. *Sravnytelniya Tablits inostrannich Vyasov y Myare se Rossiskemy, costavleniya Kommissiou cotshrezhdenuou dla privediniya vye edinoobrasie Myare y Vyasov.*

(Comparative Tables of foreign weights and measures, published by the Committee for effecting uniformity of measures and weights. St. Petersburg, 1836.)

A collection of 160 tables, containing all usual and obselete European weights and measures reduced to their Russian equivalents; this work, however, is rather a kind of "ready reckoner" than a scientific compilation; none of the data are expressed in decimals.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.*

By R. A. Peacock, Jersey.

(*Continued from page* 125.)

Chapter II.

The Sinkings have been sudden, not continuous.

13*a*. The catastrophes about to come under consideration, have not been gradual and continuous, consisting of so many feet and inches per century; as is the case on the south of Sweden. The country to the north of S. Malo is described by the historian as having been "swallowed up in an instant;" whilst the vast tract of Britanny inundated, but afterwards recovered by embanking, appears to have gradually sunk from day to day for several days, without any sudden shock of the nature of an earthquake. The sinkings about Jersey in 1356, so far as can be gathered, appear also to have been sudden; of the nature of the more ancient sinking about Elizabeth Castle, there is no record. With regard to those about Guernsey, there does not appear to be any record either of the time or the manner of their occurrence.

I have before me "A Survey of the Islands of Guernsey, Sercq, and Herm, with the surrounding dangers," by Capt. Martin White, R.N. (Published by the Admiralty, August 30th, 1822, and corrected by Capt. White to 1840. Scale about 2in. to a geographical mile.) Also a "Chart of the English Channel Islands, Guernsey, Herm, and Serk, surveyed by Commander Sidney and J. Richards, Master R.N., 1859-62," with corrections to March, 1864, on a scale of about 4in. to one geographical, or sea mile. And by drawing corresponding lines on each chart across the Great Russel Channel, from Sercq, &c., on one side of the Channel to Herm, &c., on the other side of it, the following table of greatest soundings has been obtained, Capt. White's soundings, which he gives in fathoms, having been first reduced to English feet.

Capt. White.† ft.	Messrs. Sidney and Richards.‡ ft.	Differences. ft.
168	127	41
180	141	39
168	124	44

From which it appears that, although Captain White's datum is three feet lower than that of Messrs. Sidney and Richards, he makes the soundings about 40ft. in addition, greater than they do. How this difference has arisen I do not know, but am certainly not at all disposed to attribute it to so great a shallowing of the water as 43ft. in the short space of twenty-four years. In Little Russel Channel, between Guernsey and Herm, I find no material difference between the two series of soundings.

I shall, doubtless, be expected to express an opinion what probability there appears to be of farther sinkings. And my view is this. Since there is no proof that any sinkings have taken place for 510 years about Jersey, and probably as long at the Northern islands, and for at least four centuries near St. Malo, I am under no apprehensions. I reside with my family

† Capt. White's "soundings denote the depth in fathoms at low water equinoctial tides."

‡ "Soundings in feet at low water, mean springs, equinoctial springs fall 3ft. lower."

literally within a stone's-throw of the sea on the south of Jersey, the house floor not exceeding 10ft. above the highest tides, and think myself as safe as in the average of localities of the *temperate* regions of the earth; and of course safer than in the *torrid* regions, where volcanoes and earthquakes are so much more common. I am disposed to compare these localities to a discharged gun. It has been discharged, and is consequently as harmless as any other combination of wood and iron.

14. *Sinkings in St. Ouen's, St. Brelade's, and St. Aubin's Bays, on the west and south of Jersey.*—The weight of what is said, depends a good deal on the ability and probable extent of knowledge of him who says it. Looking at Mr. Poingdestre's testimony from this point of view, it may safely be affirmed that he was a learned and pains-taking antiquary, and a gentleman of great abilities and acquirements. He makes no claim to be a geologist; in fact, in his time, geology was only struggling by the efforts of Steno, Scilla, Plot, Lister, Leibnitz, and Hook,* through clouds of error and conjecture into the dignity of a science.

Biographical.—John Poingdestre was born in Jersey in 1609. He became a Fellow of Exeter College, Oxford, and was one of the best Greek scholars in the University. He was ejected from his fellowship for his loyalty by the Parliamentary visitors. His skill in languages, his acquaintance with the civil and Roman laws, and his other acquirements, introduced him into the Secretary of State's office under Lord Digby, where he continued until the affairs of Charles I. had grown desperate. He afterwards assisted in the defence of Jersey and Elizabeth Castle against the "rebels," as Falle calls the Parliamentary forces. After the Restoration he was made Lieutenant-Bailly of Jersey, and died in that island, in his eighty-third year, in 1691. He had from his earliest days been collecting all the historical antiquities he could find in print or upon records.†

He is the author of No. 5,417 of the Harleian MSS. of the British Museum, which is a historical sketch of Jersey, consisting of 44 folios or leaves, quarto size, bound in Russia leather, and profusely gilt over the backs. There is no date. It is written neatly and clearly since Camden's time, for the first chapter commences with the words:—"The isle of Jersey in Mr. Cambden's accompt," &c. On the first fly leaf occur the following words, in a different handwriting, and evidently ancient:—"This did belong to King James I had it from Coll. Grahme." The title of the book is "Cæsarea, or a Discourse of the Island of Jersey in two parts. The first an accompt of it as it is at present. The second Some Historicall observations relating to antiquity." He presented this MS. to King James II. on his accession to the throne, which event occurred February 6th, 1685. The date of the book is important, because, as we shall presently see, Poingdestre mentions that "the sea hath overwhelmed within these 350 years the richest soile" of the parish of St. Ouen's. Deducting 350 from 1,685 gives 1,335, which is an answer to those who allege that there have been no sinkings in this locality within the historical period. We must necessarily adopt the date 1356 for the submersion of St. Ouen's forest, as there is direct testimony to that effect. Of course Poingdestre's period of 350 years from 1685 embraces 1356. He says in the same sentence that the land extended "very farre into the sea," which, in connection with other testimonies to be hereinafter given, is an answer to those who contend that the lost land was a mere narrow belt along the present coast. Though the present writer neither affirms nor denies the well-known tradition that the only wate between Jersey and France was once capable of being crossed by a plank, yet neither does Poingdestre disprove that tradition by showing that Jersey has been an island ever since Antoninus' Itinerary, (so-called) was written. First, because if an island at *high* water, the space between it and France may have been dry or nearly so at *low* water; it being possible to cross even yet at extreme low water, without going into water more than about four fathoms deep. And second, because as will be seen presently, Jersey was probably part of the Continent in Cæsar's time, and still later.

15. The following is an important extract from Poingdestre's MS.

"Of things detrimentall."

CHAPTER XV.

"I have been ouer prolixe in discoursing of those things which may be of some beauty or advantage to the Isle of Jersey. Bona fides requires that I should not conceale the other things, which may seem to be of the some deformity or disadvantage to it. It cannot be denied but that the said Isle of Jersey is much beholding to the sea, yt supplies it so abundantly with bread and firing, that is with Vraic an excellent fewell and manure for ye ground, both burn't and unburn't, besides fish, navigation, and other conveniencyes which ye sea affoards. But if one consider the great diminucions which ye sayd Island hath suffered both of old time and lately by inundations and sands, it will be hard to say whither those advantages or those losses be y greater, for first it appears by history that ye Islet nowe about a mile distant from the land was about eleven hundred years ago ioyned to it:* for St. Maglorius settled himselfe there or erected a Schoole of Christianity, which was continued until at last it was converted into an Abby, of which the shallowness of the sea between that small Island and ye Towne, and all along ye coast towards St. Albin, and between ye fort there and ye next part of y land, is noe contemptible testimony: [?] If soe, it is not harde to guesse what a tract of good land hath been lost by that incroachment of the water. Next it is acknowledged, and ye records of those times testifye it, that in ye parish of St. Ouen, the sea hath overwhelmed within these 350 yoars the richest soile of that parish, that is a vale from beyond the Poole towards Lestac in lenght, and in breadth from the hills very farre into the sea, and that to this day stumpes of oakes are found in ye sand during the Ebbe, and some ruins of buildings among the rocks: the like whereof is also seen in the Bay of St. Brelade." It will now be convenient to interrupt the quotation from Poingdestre, in order to corroborate him; and, in passing, to mention the following interesting fact, for which I am indebted to my friend, T. W. Clarke, Esq., of her Majesty's Customs. He says four trees, one of large size, were seen in the Bay of St. Brelade's, in April, 1866, lying in the sand, near the centre of this bay and at about half tide mark.

16. A paper, of which the following is a copy, was given to the present writer in February, 1860, by Mr. George Mauger, of St. Lawrence Parish, Jersey, who said he had copied it from the "*Gazette de l'Isle de Jersey*, du 28 Avril, 1787, imprimée par Math. Alexandre":—

"*Troncs d'Arbres* decouverts à St. Ouen, Jersey, pendant l'Hiver, 1786.

"Il faudrait posséder une philosophie plus qu'humaine pour concevoir les révolutions étonnantes qu'a subies la face du globe, depuis le commencement des temps jusqu'à present: je n'entends pas des revolutions politiques; c'est du naturel que je veux parler.

"Ce petit pays que nous habitons nous en fournit des preuves assez curieuses. Les troncs et les racines d'arbres qui se sont decouverts l'hiver dernier, par l'agitation de la mer, dans la Baye de S. Ouen, et qui sont encore visibles, nous fournissent un sujet de contemplation dans des temps fort reculés. On voit des milliers d'arbres couchés les uns près des autres dans cette baye, depuis la Corbière † jusqu'aux deux bancs de sable à quelques milles du plein de la mer.‡ Par ces débris antiques on ne peut douter que tout ce terrein, aussi bien que celui au-dessus, appelé les miellos, n'ait été autrefois de riches prairies et des forêts épaisses, qui ont été submergées par quelque événement extraordinaire. Parmi ces arbres on en voit de forts gros, et on assure qu'après une tempête de certains vents, il viennent si au-dessus du sable qu' il est fort difficile pour des chariots de passer.§ Peut-être les Bayes de S. Helier, de S. Clement et de Grouville, qui sont étendues, ont-elles subi le même sort, et que la mer qui n'est agitée dans ces endroits là ne nous découvre rien de semblable; car il est à remarquer que ce n'est que rarement et après de gros vent que ceux dans la Baye de St. Ouen sont rendus visibles."

The "miellcs" is now called "les Quenvais." This is still high above the sea, having only been submerged by sand drifted from the shore.

* Lyell's *Principles of Geology.*

† See Falle's *History of Jersey* and its preface by the Rev. Edward Durell; Tupper's *History of Guernsey*, &c.

* This gives the date of the separation in 485. We shall find further on the year 687 given. And the Editor of the MS. *Chroniques de Jersey*, writing in 1832 (p. 242), says it happened 1175 years ago, which gives the date 657.

† The S.W. angle of Jersey.

‡ Rigdon Shoal and Great Bank are respectively about two and three miles from high water.

§ The beach was then a public road.

On Great Bank the soundings are from 7 to 9 fathoms at low water and the groatest rise of tide is 42ft. And if we suppose the original forest to have been 10ft. above high water (it can hardly have been less), we shall have a sinking of at least 100ft. It will presently be seen that the three bays he names "were subjected to the same fate" of having sunk.

17. *St. Ouen's Bay.*—On the 26th April, 1861, at St. Aubin's, Jersey; the Rev. G. J. le Maistre, head master of the grammar school there, and medallist, T.C.D., made the following statement, which the present writer took down in writing. He said that, "fifty or sixty years ago his father, who is now dead, saw a good many stumps and roots of trees, standing apparently *in situ* where they had grown, below low water. They were near L'Etacq village at the north end of St. Ouen's Bay. Whon his grandfather, now also dead, took his father there, ho looked out for the remains of a brick house which he had formorly seen, and more particularly for a stone trough for watering cattle. From which he (the Rev. G. J. le Maistre) infers that his grandfather must have previously seen theso things in the same part of the bay as aforesaid. His grandfather was born in 1754."

18. Vice-Admiral White, a resident of Jersey, and who has since died there on July 2nd, 1865,* was formerly Capt. Martin White, R.N., and by direction of tho Lords Commissioners of the Admiralty he made a survey abont 1822, which he corrocted up to 1840, with very numerous soundings of the Channel Islands seas; from which, with the assistance of some soundings from the beautiful large scale charts of the French Government, the map annexed has boen prepared, and the statoments contained in these papers have boen obtained. On May 22nd, 1860, he personally stated to the present writer that "in taking soundings he saw two or three stumps of trees in St. Ouen's Bay, a little outside of low water. They were fixed in tho soil, or sea bottom, near la Pule or Pinnacle."

18*a*. After several personal attempts to find in St. Ouen's Bay at extreme low tides stumps or roots of trees, the writer has not succeeded in finding any except at and on the beach, at a maximum depth of about 8ft. below high water. On May 18th, 1859, on the beach a few hundred yards south of L'Etacq village, there was an old oak lying prostrate with its root south and top north, a little below high water. On July 4th, 1859, the writer measured along the beach of St. Ouen's Bay, from the westerly angle of the British Star Hotel, 1,250 yards southward, and at that place there commenced a space of beach extending 115 yards southward by 20 yards wide, on which trees had formerly grown, for there were both stumps and roots. One tree mnst have been a very large one. Generally the stumps were gone, bnt there were abundance of roots radiating from the places where each tree had stood; and at about a quarter of a mile further along the beach were other stumps of trees. The whole are often coverod up and hidden by the shingle, being covered and uncoverod by the tides. The present writer's not having seen any terrestrial remains far out in St. Ouen's Bay is of no importance, bocause, as has been stated, there is plenty of good and reliable testimony of gentlemen who have seen them.

19. On April 27th, 1861, Mr. Le Feuvre, of Le Hogue, St. Peter's parish, Jersoy, personally informed the writer that there are quantities of submerged trees in St. Ouen's Bay, due west of the pond. He has seen two *in situ*, with upright trunks broken off at two or three feet high. He and the writer went to look for them at low water of an equinoctial spring tide, but they were covered up, as they often are, by the wind and waves having drifted sand over them.

St. Ouen's pond is about opposite the *middle* of the bay, the village of l'Etacq and the tower-like rock called the Pinnacle being at the *north end* of the bay. Thus a second submerged locality is identified.

20. The late Mr. Daniel Janvrin, a banker of St. Helier, then at an advanced period in life, who with his forefathers were natives and inhabitants of Jersoy, on May 14th, 1860, personally informed the writer that his great-grandfather remembered there being a forest at La Pulente, at the *south end* of St. Onen's Bay; and that his said great-grandfather either paid or received, he does not remember which, a corn rent on account of it. This must have been a payment, not a receiving, because the forest belonged to the Crown. It is known that John Wallis (Seigneur); proprietor of tho sunken forest of St. Ouen's, forfeited his estates to the Crown for joining in the Earl of Warwick's rebellion. The Earl and he were both killed at the battle of Barnet, which is known as a matter of history to have occurred in 1471.

21. February 21st, 1865, Mr. P. J. Simon, receiver of the Queen's rents in Jersey, informed the writer as follows, by reference to his books of account:—"There were rents payable for allowing pigs to go into the former forest of St. Ouen's Bay, but those ronts are not now collected. The small rent of three sous payable three timos a year for a right of road from St. Ouen's church to the shore, called *Percage,* has beon orroneously supposed to have been paid for the pigs, under the supposition that it meant *Pourcage.* But *Percage* is probably derived from *Percer*, to pierce, or break through. He doos not know any manor callod La Braquette, but there may be a house of that namó iu St. Ouen's parish. The fiefs Handoys, in the parish of St. Lawrence, Grainville, and Pesnel (which last is very small), in St. John's parish at Mont Mado, and Morville and Robilliard, in St. Ouen's parish, along with the formor forost iu St. Ouen's Bay, were formerly all comprised in the Seigniory of St. Germaius, of which more presently. The payments made for the pigs come under the head of "Herbage," but the books contain no details of any animals in especiall. Mr. Simon has no doubt that there was once a forest in St. Ouen's Bay."

22. Mr. Simon's statement wlll have preparod the roader to believe that snch statements as the following, may bo heard now and thon in the parish of St. Ouen's, as is really the case. On the 7th July, 1857, the writer accidentally met at the village of St. Ouen's, Mr. John Breard, of St. Ouen's parish, aged 83; who stated that his brother, who had died a few months before, used to pay a rent for tho privilego of putting his pigs into the forest of St. Ouon's, though it had long since boen dostroyed by the soa. It is well known that royal rights are never lost, so long as it is thought proper to enforce them.

23. In 1826, "A brief description of the Island of Jersey," was published by Messrs. Le Lievre, publishors and booksellers, St. Helior. The author's name is not given, but it is known.* And it is known also that ho was a gentleman of ability, and that he had iutimates in official positions, who were well qualified to give him authentic information. He says, page 13, speaking of the Bay of St. Ouen's: "At a period not more remote than the end of the fourteenth century, or begiuning of the fifteenth century, groves of oaks and fertile meadows occnpied a portion of the bay, now proudly triumphed over by the usurpiug billows. At some particular seasons of the year, when the tide recedos to a greator distance than usual, the stoms of trees are still observable, and what will causo us still further to lament the inundation, what onco were the habitations of mon. As the irruption from its force must uecessarily have been sudden, and its progress rapid, we scarcoly nced speculate on the fate of its inhabitants. That the calamity was very extensive, and the loss of property groat, is known with a certainty which it would bo vain to doubt. A record is still iu existence granting to an inhabitant of the parish, the privilege of fooding his herds of swine in the forest of St. Ouon's, aud tho following extract from a patent issued in the reign of Charles II.,† givos mauy particulars of the district now lost, and affords us some information respecting the proprietor of the greatest part of the territory thus calauitously inundatod. The fief Morville and Robilliard, being a part and parcel of tho fief of St. Germain, in tho island of Jersey, appertainod aucieutly to a gentleman of the name of John Wallis; his manor was situated on the same fief in the valley and country of a village called l'Etacq, on the borders of the sea, and was called the manor of la Braquette, near which there was a forest of oak and other largo trees, on the east and north of the said manor, which is uow below high-water mark. The said valley and manor have for many yoars been covered by the soa; nevertheless, whon the soa goes down, thoro are still seen remains of the said manor; aud after a tempest and damage caused by the sea, is found a quantity of large oak trees, whero formerly was the said valley of l'Etacq. After tho soa had so over-run its bounds, the said Wallis

* This amiable gentleman and accomplished scientific officer attained the ripe old age of eighty-four years.

* R. Haynes, Esq.

† The writer has not been able to obtain a sight of any copy of this patent.

retired to the parish of St. Laurence, in the said island, where he built a chateau, now in ruins, which is called the chateau of St. Germain." St. Lawrence is the central parish of Jersey.

24. The following most interesting and important statement was given me by Mr. George Mauger of St. Lawrence. Quoted from the *Almanach de Jersey* for 1849, of which I have not been fortunate enough to obtain a copy.

(Extrait d'un Ancien Manuscrit.)

Ravages causés par la Mer à Jersey.

"En l'année 1356, dans la paroisse de St. Ouen, la mer engloutit un assez riche canton de terrain. Les Registres de l'Echiquier font mention d'un peuple qui habitait cette portion de terre.

"La Forêt de la Brequette fut renversée et engloutie par l'affreux ouragan d'alors.

"En ladite année 1356, John Maturins était Gardien de Jersey (aujourdhui Governeur), et Guillaume Hostein était Bailli de cette dite Isle.

"En l'an 1495, un grand banc de sable fut jeté par une tempête au plein de la mer qui monta et couvrit et ensevelit cette longue étendue de terre à l'ouest de la dite Isle, laquelle ressemble à un désert; et suivant toutes les apparences, que le grands vents de l'Ouest qui soufflent ici dans toutes les saisons et une partie de l'année, ont élevé le sable qui a causé ce désastre.*

"Il y a environ 1134 ans que la petite Ile où est bâti le Chateau Elizabeth fut détachée de la terre ferme, vers l'an 687." This gives date 1821; *i.e.*, 1134 + 678 = 1821.

"N.B. Par une ancienne tradition, il est pretendu que la maison de M. de St. Germains fut ensevelie sous les sables de l'Ouest de ladite Ile, et qu'ensuite ayant fait mesurer l'île en longueur et largeur, il fit bâtir une maison au milieu, située en la Paroisse de St. Laurens, laquelle porte encore aujourdhui le nom des St. Germains; mais je n'ai jamais rien vu qui autorise cette tradition."—From the Jersey Almanack, 1849, p. 99, publié par Perrot et Huelin, au le Bureau de la Chronique.

25. There are extant eight or ten copies in MS. of a M.S. of the date of 1585, entitled *Chroniques de Jersey*, by an anonymous writer, who was probably one of the de Carterets of St. Ouen's Manor, one of the most distinguished families of the island. A copy of one of these was published in Guernsey, in 1832, by Mr. George Syvret, and republished in Jersey by Abraham Mourant, Ecrivain, in 1858, who gives ten pages of errata, addenda, and corrigenda to the 1832 edition. The Rev. Edward Durell, then rector of St. Saviour's, in Jersey, republished, in 1837, Fallo's *History of Jersey*, and he says the Chroniques "is a valuable performance, the publication of which is an important acquisition. As to their veracity, it is confirmed by the Records (of Jersey) in many particulars.† and there is little doubt that most, if not all, of their chivalrous embellishments are true." Mr. Durell reminds us that in virtue of his right as one of the twelve rectors of *The States*, he had access to the Records. It appears from Chapter III. of the printed edition of the Chroniques of 1858, that Robert de Norton and William de la Rue, Commissioners appointed by King Edward III. in 1331, ascertained that at that date, amongst the possessions of the Seigneurs named, the then Seigneur of St. Germain's (p. 12), possessed the fiefs "Granville, Morville, Handois et Pesnel." By the politeness of Mr. T. W. Rose, the writer has been enabled to peruse one of the MS. copies which belongs to him, and which has every appearance of being as old as 1585, and which contains the statements above given, and enumerates the seigniory and fiefs as follows:—"Le Seigneur de St. Germain, Grainville, Morville, Handoye, etc., and Fieu Posnel." And afterwards, "St. Germain, Handoye, Grainville, le fieu Ponel, le fiou Cheney, et lo fieu de Morville."

It is stated in *Chroniques de Jersey*, p. 236, not as part of the ancient MS., but as part of "a Historical abridgement concerning the isles of Jersey Guernsey, Auregney, and Serk," by George S. Syvret, that, "In the parish of S. Ouen, the sea has swallowed up a very rich district within about 400 years," [this would give the date 1432, as he writes in 1832, but 1356 was probably the correct date] "which one may compare to the parishes du Valle and St. Sampson, in the Isle of Guernsey, and this country is now called the Bay of St. Ouen," &c.

The forest of St. Ouen's no doubt belonged to a Wallis, Seigneur of St. Germains, at the time of the submersion.

It has been suggested that the rocks about Elizabeth Castle have probably experienced no change *since* the building of St. Helier's Hermitage, which still exists with its arched stone roof in very fair repair, because, it is said, such a change would probably have fractured the building, if not brought it down entirely. From Lecanu's *Hist. des évèques de Coutances*, p. 48, we learn that St. Helier was martyred in Jersey about A.D. 578. This argument, however, is by no means conclusive, because the hermitage is very small, and the rocks may have quietly and slowly settled down without any shock, as we shall see in due time that leagues of land settled down in Britanny, day by day, and *so quietly* that nobody suspected the ground was sinking.

26. The word "Grune" and its plural "Grunes" will be observed to occur a good many times on the annexed chart. It is an obsolete French word signifying *low marshy ground*, and is perhaps the equivalent, or it may be the origin of our English word "Ground," which is still pronounced ***Grund*** by the country people in the north of England. And Grün is ***the green*** in German. Metivier of Guernsey says, "The root Grune is Cymric, Gröyn, pebbles, ridge of pebbles formed by the sea; basbreton, green gravel. And though it is not contended that the fact of many marine rocks being now called "Grunes" is of itself conclusive evidence that those rocks have been dry land within the last nineteen centuries, yet neither, on the other hand, would it have been right to omit all mention of the circumstances just stated. The following is a descriptive account of the positions of some grunes in St. Aubin's Bay, which could not be conveniently marked on the chart for fear of over-crowding. Petite Grune is 9-10ths of a mile W. by S. of Noirmont Tower. Grand Grune, 1 mile S.W. by W. Grunes Vaudin S.W. rocks, $1\frac{1}{4}$ mile S. by W. Grunes aux Dards, 9-10ths of a mile S.S.E. Grunes St. Michel, $1\frac{1}{2}$ mile S.E. by E. Grunes de Port, $\frac{1}{2}$ mile E. These are bearings (true, not magnetic), from Noirmont Tower, which is at the western extremity of St. Aubin's Bay. Trois Grunes are $1\frac{1}{4}$ mile S.E. by S. from Elizabeth Castle. The word Grune has been inadvertently applied on some of the charts to high marine rocks; which is no more true than it would be to call the top of a mountain, a valley.

27. Capt. Ranwell, R.N., informs the writer that he was at Jersey with his ship in 1812, and there were then to be seen stumps of trees near low water mark, in the north-west part of St. Aubin's Bay near St. Aubin's Tower. He did not see them, but several of his ship's company saw them. The highest tides rise in St. Aubin's Bay 42ft.

28. The writer has been credibly informed that two or three years ago, stumps of trees were found in the bottom, which the tide never leaves, outside of St. Helier's harbour, near Crapaud rock.

29. The following has been communicated by Mr. Mauger, of St. Lawrence:—

"*Chronique de Jersey*, du Mercredi, 7 Avril, 1847.

"Les excavations que l'on fait en ce moment pour asseoir les fondations de la Nouvelle Chaussée du Nord viennent ajouter des preuves incontestables à l'appui de l'assertion de plusieurs historiens, que les rochers sur lesquels sont construits le Château Elizabeth et l'Ermitage formaient jadis partie du littoral, c'est-a-dire que le grand espace connu sous le nom de Baie de S. Aubin était recouvert de terre et élevé au-dessus du niveau de la mer haute. A cinq ou six pieds de profondeur, les ouvriers trouvent une riche terre végétable et une profusion de racines d'arbres en parfait état de conservation. Nous devons ajouter, dans l'interêt de nos agriculteurs, que cette terre, qui doit être un excellent engrais, est à la disposition de ceux qui voudront en prendre pour leur usage."

Mr. Jurat Nicolle says that nuts, as well as stumps and roots of trees, were found in sinking the foundations of the new pier.

30. May 7th, 1865.—The present writer examined the sandy surface where the brook runs down on the north-west of the long pier of the new

* This sentence has nothing to do with the sinking, it refers only to the drifting of sand from the shore over the Quenvais, with which the latter is still covered about three yards thick.

† A great quantity of the Jersey Records was unfortunately burnt many years ago.

harbour of St. Helier, and found numerous remains of trees. They were mostly decayed, and contained numbers of sandworms, which were devouring them. There were several parts of trunks of trees of from one to five yards long, lying prostrate on the sand in a direction about north-west and south-east. Some of these trees when entire had been as thick as a man's body. Had one stump with parts of the roots dug up, and brought it away, and afterwards exhibited it before the Geological Section at Birmingham. Am not certain of the species, but think it is birch. Another larger stump was attempted to be got up; the interior from its great resistance must have been sound; it was probably an oak. The spade broke, and the writer was not sorry to leave this stump *in situ*, where it is to be hoped it will long remain as an interesting record of the remarkable position of an ancient forest. Many of the remains of the trees are quite rotten, and must soon be carried off by the action of the sea. The trees extend from about where the brook issues from the pier wall, south-westwardly and parallel to the wall, to a place about 180 yards short of the principal angle of the wall near the wooden shed. One large trunk of a tree, about three yards long, the upper half of which is gone, lies transversely across the brook opposite the highest part of a low expanse of rock, where the greatest rise of tide must be about 18ft. or 20ft. Some of the stumps of trees are in an upright position with roots inserted in the sandy loam; such was the one brought away. The trees can be seen from the parapet of the pier without going down upon the sand, and it is to be hoped that gentlemen will be very moderate in taking away specimens, otherwise these curious and important relics must soon become extinct.

Saturday, Sept. 2nd, 1865.—Re-examined these stumps, and took one of them (oak), and exhibited it, as well as the former one, to the Geological Section at Birmingham, when reading a paper on the subject on Sept. 9th. It was decayed, except the heart, which was light brown, nearly the natural colour, and was generally thought not to have been long submerged.

31. To the south-westward of the Engineers' Barracks, which are at the south end of the Fort Regent, is a rock called *Les Quesnais*, *Quesne* signifying in the ancient language the modern *Chêne*, an oak, and *Quesnais* means a wood of oaks, *i.e.*, plural number, as if formerly there had been a forest of oaks there. The Quesnais is a full mile seawards, from present high water. It is covered at high water. At all events, it is right to have stated these circumstances, whether it be true that Les Quesnais once formed part of the Isle of Jersey, or not.

In the "reference" to the Diagram last month the following explanations were omitted:—A A A, position of the forest *before* the ground sunk; B B B, position of forest *after* the ground sunk.

More than twenty years ago the writer had tide staffs erected in Morecambe Bay, and, except when the water was disturbed by strong winds, he found half-tide level was at a uniform height, both in spring, neap, and medium tides.

THE PANAMA, NEW ZEALAND, AND AUSTRALIAN ROYAL MAIL COMPANY'S NEW STEAM-SHIP "KIAKOURA."

We have occasion to mention the remarkably quick passage just made by this splendid screw-steamer, from Plymouth to the Cape of Good Hope. She made the passage in 26 days, steaming the whole distance; averaging 235 miles per day.

She was built by Mr. Lungley, of Deptford, who has been so successful with the ships of the Union Company's Cape Mail service. The engines, with surface condensers, were designed by Mr. George Allibon (the present resident engineer of the Millwall Iron Works and Ship Building Company), and afford another proof, if it were wanting, of the great skill and care bestowed by that gentleman upon work entrusted to his care and direction as a marine engineer.

The *Kiakoura* is more than 1,500 tons, builder's measurement; and at the time of leaving London she had upwards of 2,005 tons dead weight on board. She has great carrying capacity compared with the builder's measurement, and has proved herself to be one of the finest specimens of marine engineering and naval architecture afloat. She has also proved to the colonists residing at the Cape of Good Hope, how easy it would be to give them a quicker communication with the mother country. We subjoin some particulars of the trial made to ascertain her consumption of coals before she left London, the coal—which was not first-class, having so much dust—being drawn promiscuously from the bunkers in buckets, and each bucket carefully weighed before being thrown upon the stoke-hole floor. During the trial the number of revolutions, pressure of steam, and temperature were noted at regular intervals. Indicator diagrams were taken from both ends of each cylinder by the government official, who attended from Woolwich Dockyard, with the instrument used on the trial trips of H.M.'s vessels. The mean results were as follows:—

Mean pressure of steam on the piston	13·3lbs.
Average revolution per minute	57
Indicated horse-power	1,616
Nominal horse-power	300
Coals consumed per hour	3,805lbs.
Coals consumed per hour per 1 horse-power ...	$2\frac{3}{10}$lbs.
Pressure of steam (average)	23lbs.
Vacuum (average)	27ins.
Temperature of feed water	115°
„ discharge water	80°
„ engine room	75°
„ stoke-hole	100°
„ sea water	48°
Speed of vessel	$12\frac{1}{2}$ knots.

We may add that the *Kiakoura* has 196ft. superficial of fire bar surface. The result of the trial showed no less than 13·5 horse-power per foot of fire bar surface.

STEAM-SHIP PERFORMANCES.

The following is the official preliminary report of the results of the trial on Long Island Sound between the U.S. Steamers *Winooska* and *Algonquin*, as published in the *Journal of the Franklin Institute.*

General Inspector's Office, Steam Machinery, U.S. Navy,
New York, February 19th, 1866.

Sir,—The undersigned, appointed by you to conduct the experiments with the competitive machinery of the U.S. paddle-wheel steamers *Winooska* and *Algonquin*, have the honour to submit the following preliminary report of the results of the trial on the Long Island Sound for maximum power of machinery and speed of vessel, and for economy of fuel under these conditions. It will be followed by a full report, embracing the results of all the experiments at the wharf as well as that on Long Island Sound, together with our conclusions from the same, and all the data *in extenso*:

The trial on Long Island Sound was intended to embrace eight consecutive double runs between Execution Rock Lighthouse and Faulkner's Island Lighthouse, passing around both. Each double run, measured on the vessel's track, was, according to the Coast Survey Chart, one hundred and thirteen geographical miles; but a violent storm, accompanied with weather so thick as to prevent the lights from being visible beyond a mile or two, and the refusal of the pilots to run in it, terminated the trial after the *Winooska* had performed three double runs, or 339 geographical miles, and the *Algonquin* two double runs, or 226 geographical miles. Our data and results are, accordingly, for these distances, respectively. Both vessels ran a portion of the distance on the next run, but that portion is omitted because the exact position of the vessels could not be determined when it was decided to anchor.

During the running time the water was smooth and the wind a gentle, variable breeze. At each terminus of the route a large field of ice was encountered, whose resistance greatly lessened the the speed of the vessels while passing through it, and their speed was also decreased by the turning of the vessels around each terminus. Neither vessel steered well; but they were about equal in this particular, which, of course, still further lessened their speed.

The machinery of both vessels was in excellent order; that of the *Algonquin*, after the completion of the wharf trials, had been for two months and a half in the hands of the contractor for repairs, during which he had renewed all the vertical tubes of the boilers, substituted a new circulating pump, &c., &c. In the course of the trial the feed pump, worked by her main engine, was inoperative ten and a half hours, during

which time the boilers were supplied by the auxiliary steam pump. As, however, this pump drew the feed water from the hot well, its substitution in no way affected the performance of the machinery. The counterbalance of the eccentric broke during the trial; but its fracture was not of the least importance. A paddle on one of the wheels was also broken; but it took place on the return of the vessel to port, and not during the trial.

With the machinery of the *Winooska* there were no accidents or derangements, and it functioned throughout with the same regularity, noiselessness, and smoothness of motion which characterised its previous performances at the wharf.

On board the *Algonquin* the blower was used; but as it delivered the blast into an open fire-room, its effect must have been very small. The steam jet in the smoke-pipe was in use, and, with the boiler pressure of nearly 68 pounds per square inch above the atmosphere, was doubtless very efficient in forcing the draft.

On board the *Winooska* the blowers were not used. They are two in number; each is driven by an independent steam cylinder, and delivers its blast into the ash-pits of the boilers, which are closed by air-tight doors. When employed, an enormous rate of combustion can be commanded, and a supply of steam much exceeding that used during the trial. A steam jet (the duplicate of the *Algonquin's*) in the smoke-pipe was employed during the trial with a boiler pressure of 38 pounds per square inch above the atmosphere.

The machinery of both vessels was fitted with surface condensers, and neither was obliged to "blow off" during the trial. The vacuum in the *Algonquin's* condenser was less than in the condenser of the *Winooska*; but as it resulted from inefficiency of condensing surface, and not from air leaks, it was attended by a correspondingly high temperature of feed water, which, to a great extent, compensated this advantage.

At the commencement of the trial the *Algonquin's* draft of water was 8ft. 5in. forward, and the same aft; while the *Winooska's* draft of water was 8ft. 10in. forward, and 8ft. 8in. aft. The difference of 4in. in the mean draft was an allowance made for the deeper false keel of the latter vessel, both vessels being presumed to be in other respects identical, as they were constructed from the same building directions and mould loft dimensions.

The paddle-wheels of the *Winooska* consisted each of twenty-four paddles. Each paddle was 9ft. in length and 16in. in breadth, and its outer edge was placed at the distance of 12ft. from the centre, making the diameter over the paddles 24ft. The total area of paddle surface in one wheel was 288 square feet. With the vessel at the above draft of water, the deepest immersion of the outer edge of the paddles was 3ft. 6in.

The paddle-wheels of the *Algonquin* were arranged by the contractor as he desired. Each wheel consisted of thirty-six half paddles, eighteen on each side, and placed opposite the interspaces of those on the opposing side. These half-paddles would have been equi-spaced, had each wheel consisted of forty-eight of them, instead of thirty-six; but, by the omission of twelve, six at diametrically opposite points, an empty space equal to that due to three paddles so spaced was left at those portions of the circumference of the wheel. All the half-paddles were of the same length—namely, 5ft.—but they were of unequal breadths, being so made and arranged on the circumference of the wheel for the purpose of producing a regular rotary motion with the high pressure steam and high measure of expansion used. The breadths of the consecutive half-paddles in inches were as follows, namely: 15, 17, 19, 21, 24, 27, 24, 24, and 21. The length from outside to outside of a pair of half-paddles was 9ft., caused by their overlapping one foot at the centre. The total area of paddle surface in one wheel, taking the length of a pair of half-paddles at 10 feet, is 320 square feet; and taking their length at 9 feet, 288 square feet. The inner edge of all the paddles was at the same distance from the centre—namely, 10ft. 8in.—which made the mean distance of their edges 12ft. 5½in. from the centre, or the mean diameter over the paddles 24ft. 10⅝in. With the vessel at the draft of 8ft. 5in., forward and aft, the mean deepest immersion of the outer edge of the paddles was 4ft. 6in.

The boilers of the *Winooska* contain 200 square feet of grate surface, and 5,036 square feet of heating surface, and had no means of superheating the steam. The boilers of the *Algonquin* contained 144 square feet of grate surface, and 2,673 square feet of heating surface, together with 1,132 square feet of steam superheating surface in tubes. The boilers of both vessels have water tubes. In the *Winooska* they are vertical, and are arranged above the furnaces according to Martin's patent; and in the *Algonquin* they are inclined and arranged in combination with the superheating tubes, according to the patent of Mr. E. H. Dickerson, who designed the entire machinery of that vessel.

Each vessel has one inclined and direct acting engine. The cylinder of the *Winooska* is 58in. in diameter, and its piston has a stroke of 8ft. 9in. The cylinder of the *Algonquin* is 48in. in diameter, and its piston has a stroke ef 10ft.

The space occupied in the *Winooska* by the machinery and coal is 67ft. 11in. long, by the entire breadth and depth of the vessel, and in this space there is a coal bunker capacity of 9,424 cubic feet. The space occupied in the *Algonquin* by the machinery and coal is 75ft. 5in. long, by the entire breadth and depth of the vessel, and in this space there is a coal bunker capacity of 6,931 cubic feet.

The weight of the machinery of the *Winooska*, exclusive of water in the boilers, is 541,718 pounds, and inclusive of the water 623,718 pounds. The weight of the machinery of the *Algonquin*, exclusive of water in the boilers, is 629,144 pounds, and inclusive of the water 701,144 pounds.

The distribution of the weights of the *Algonquin's* machinery was so excessively faulty, that when the vessel was fully stowed for sea, with her coal bunkers filled, water in boilers, etc., she had a list of 22in. to port, giving her port paddle-wheel an immersion of 7ft. 7½in., and her starboard paddle-wheel an immersion of 3ft. 7½in. To bring the vessel upright there was required a weight of 73 tons to be stowed on the berth and spar-decks in the extreme wing, after the hold had been re-stowed in such manner as to place all the weight possible on the starboard side. This additional weight of 73 tons required to be continually trimmed as the coal was used from the bunkers; of course, it added just that number of useless tons to the vessel's displacement, and if it be added to the weight of the machinery, to which it was simply a counterbalance, it will swell that weight to 866,664 pounds.

The following are the principal dimensions of each vessel; the greatest immersed transverse section and the displacement correspond to their drafts of water at the commencement of the trial:

Depth from lower edge of rabbet of keel to mean load-water line	8ft. 2½in.
Length on mean load-water line from the forward side of the rabbet of stem to the after side of the rabbet of the stern post	240ft.
Extreme breadth on mean load-water line ...	35ft.
Displacement	1280·78 tons.
Area of the greatest immersed transverse section	263·85 sq. feet.

On commencing the trial in Long Island Sound, the vessel started abreast at Execution Rock Lighthouse, after having steamed from the Brooklyn Navy Yard to that point. The machinery of the *Algonquin* was operated by four engineers from the merchant service, employed by the contractor for that purpose; the naval engineers on board merely took the data of the performance, but in no wise interfered with the management of the machinery, which was exclusively in the hands of the contractor's engineers.

During the time the machinery of both vessels was in operation, a complete steam-log of the performance was kept, in which was noted in proper columns, at the end of each hour, the number on the counter, the number of revolutions made by the engine per minute during the hour, the steam pressure in the boiler and in the main steam pipe near the engine, the vacuum in the condenser, and the position of the throttle valve, the temperature of the atmosphere on deck, of the engine room, of the fire room, of the injection water, of the discharge water, and of the hot well or feed water; also the height of the barometer in the engine room. An accurate account was kept of the coal thrown into the furnaces each hour, and of the refuse therefrom withdrawn from the furnaces and ash-pits at the end of each watch of four hours. At the end of every half hour an indicator diagram was taken from each end of the cylinder, and the complete data marked on it at the time of taking, such as number of revolutions of the engine per minute, steam pressure, vacuum, etc. A naval engineer was always on watch in the fire room and in the engine room of each vessel, making two engineers to a watch.

In the table hereunto appended will be found the totals and means of all the above quantities and the calculated results therefrom.

The point at which the steam valve of the *Winooska* closed and cut off the admission of steam to the cylinder, was, measured on the main crosshead guides, 6ft. 4in. from the commencement of the stroke of the piston on the lower stroke, and 6ft. in the upper stroke. The mean point of cutting off was, therefore, at seven-tenth of the stroke of the piston from the commencement. As the cut-off of the *Algonquin* was not a positive one, the point of cutting off was obtained from the indicator diagrams as is the mean given by them.

The following are the guarantees of the contract for the machinery of the *Algonquin*, and it was the object of the trials at the wharf and in Long Island Sound to ascertain if they were fulfilled, and if not, to what extent they were deficient:

1. That all the materials, workmanship, detail, and finish shall be first class.

2. That the whole performance shall be of such a character as to demonstrate the satisfactory strength, reliability, practical efficiency, and durability of the entire machinery.

3. That the variations from the specifications those of the machinery of

the *Winooska* hereunto attached, to the contract for the machinery of the *Algonquin*, and forming part of this contract, are to be in the dimensions and arrangements of the cylinder and such parts as are thereby affected in the design of the valve gear, and in the type and arrangement of the boilers, and also in the surface condenser. These changes are not to increase the weight of the machinery, nor the space occupied by it, nor to decrease the weight of coal carried in bunkers within the limits allowed for the engineer department with the machinery described in the attached specifications, that is the specification for the *Winooska's* machinery.

4. That if on the completion of the machinery, and a careful trial thereof, by such persons as may be directed by the secretary of the Navy, it shall be found by them that its performance, either in amount of power developed, or in the cost *pro rata* of that power in coal, is less than those of the machinery described in the attached specifications, the specifications for the *Winooska's* machinery, will remove it and replace it at their own cost with the machinery described in the attached specifications.

The contract for the *Algonquin's* machinery also provides that the entire responsibility of fulfilling the guarantees is to rest with the said parties of the first part, who will make their own working drawings, and arrange and proportion the details of the said machinery in such manner as they shall deem best calculated to secure the most successful operation.

With regard to the first and second of the above guarantees, we have to say that, in our opinion, they have not been fulfilled. The *Winooska's* machinery has worked in the most perfect manner throughout, and its performance in every particular leaves nothing to be desired for efficiency in a paddle-steamer. Its durability and reliability could be depended upon for any length of cruising. Its workmanship, material, finish, accessories, and appointments, are first-class throughout. The machinery of the *Algonquin* is wanting in these particulars, and in proper adaptation for marine purposes. In style, finish, and conveniences for manipulation, and in accessories and appointments, it is much inferior to that of the *Winooska*.

With regard to the third guarantee, we find the machinery of the *Algonquin*, including water in boilers, to be 77,426lbs. heavier than the machinery of the *Winooska*, including water in boilers. This excess of weight is one-eighth of the weight of the *Winooska's* machinery. If to it be added the 73 tons of extra ballast required to keep the vessel upright on account of defective distribution of the machinery, the excess of weight for the *Algonquin's* machinery will be 242,946lbs., which is 39 per centum of the weight of the *Winooska's* machinery. This excess of weight requires about 8in. of draft of water to furnish the necessary displacement for it, and, of course, greatly lessens the value and efficiency of the vessel.

The space occupied in the length of the vessel by the machinery and coal of the *Algonquin* is 7ft. 6in. greater than the corresponding length in the *Winooska*. This is equivalent to 11 per centum of the space occupied by the machinery and coal of the *Winooska*; yet, in the larger space thus occupied in the *Algonquin*, there is only 6,934 cubic feet of coal bunker capacity, while in the lesser space occupied in the *Winooska* there is 9,424 cubic feet of coal bunker, the *Winooska* thus carrying 36 per centum more coal than the *Algonquin*.

The contractors have therefore signally failed in fulfilling the third guarantee.

With regard to the fourth guarantee, we find that the machinery of the *Algonquin* developed only 54.29 per centum of the power developed by the machinery of the *Winooska*, and that the cost of the indicated horse power in pounds of anthracite consumed per hour with the machinery of the *Algonquin* was 18.58 per centum more than with the machinery of the *Winooska*, taking that of the latter for unity. If the comparison be made, as it properly should be, for economy of fuel, by taking the combustible matter of the coal instead of the coal itself for the expression of the cost of the power, as the per centum of refuse in ashes and clinker is an accidental and variable proportion, then the cost of the indicated horse power in pounds of combustible consumed per hour with the machinery of the *Algonquin* was 23.28 per centum more than with the machinery of the *Winooska*. In this most important gurantee for amount of power and economy of fuel, the failure of the contractors is the greatest of all, resulting in a loss of speed of nearly two geographical miles per hour, and a large increase of the cost of the steam power, *pro rata*.

In every point guaranteed by the contractors for the *Algonquin's* machinery, they have failed, and we are of opinion that it is totally unfit for the naval service.

The steam logs of the experiment and the indicator diagrams are herewith forwarded.

Respectfully submitted by, sir, your obedient servants,

Robert Danby,
Edwin Fitbian,
Mortimer Kellogg,
Chief Engineer, U. S. N.

Hon. Gideon Welles, Secretary of the Navy.

Data and results of the trials of the U. S. paddle-wheel steamers *Winooska* and *Algonquin*, on Long Island Sound, between the Light-houses on Execution Rock and Faulkner's Island, to ascertain the relative amount of power developed by the machinery of the respective vessels and the cost of the same, *pro. rata*, in fuel.

——	Winooska.	Algonquin.
Date of commencing trial ...	3 P.M., Feb. 13, 1866.	3 P.M., Feb. 13, 1866.
Vessel's mean draft of water at commencement of trial in feet and inches	8ft. 9ins.	8f. 5ins.
Vessel's greatest immersed transverse section in square feet	263·85	263·85
Vessel's displacement in tons	1280·78	1280·78
Mean immersion of outer edges of paddles at commencement of experiment in feet and inches	3ft. 6ins.	4ft. 6ins.
Duration of the experiment in consecutive hours and minutes	28hrs. 53min.	22hrs. 54min.
Total distance run in geographical miles	339	226
Total number of revolutions made by the engine	36436	24700
Total number of pounds of anthracite consumed.........	101490	51800
Total number of pounds of ashes and clinker from the anthracite	19700	8400
Total number of pounds of combustible consumed......	81790	43400
Per centum of anthracite in ash and clinker	19·41	16·21
Pounds of anthracite consumed per hour	3513·799	2262·009
Pounds of combustible consumed per hour	2831·737	1895·196
Pounds of anthracite consumed per hour per square foot of grate surface	17·569	15·708
Pounds of combustible consumed per hour per square foot of grate surface.........	14·159	13·161
Pounds of anthracite consumed per hour per square foot of heating surface	0·697	0·845
Pounds of combustible consumed per hour per square foot of heating surface	0.562	0·708
Number of revolutions made by the engine per minute...	21·025	17·977
Steam pressure in boilers in pounds per square inch above the atmosphere	38·00	67·85
Steam pressure in main steam pipe near the cylinder in pounds per square inch above the atmosphere	34.03	64·70
Proportion of the throttle valve open	0·475	Wide.
Steam cut off at from commencement of stroke of piston	0·705	0·126
Vacuum in condenser in inches of mercury............	26·26	22·80
Barometer	30·12	30·16
Mean gross effective pressure on piston, in pounds per square inch, by indicator...	34·721	28·055

	Winooska.	Algonquin.
Pressure of the steam in the cylinder at the end of the stroke of the piston in pounds per square inch above zero	22·50	11·53
Mean back pressure against the piston during its stroke in pounds per square inch above zero	1·71	4·35
Gross effective horse power developed by the engine ...	1010·874	548·794
Pounds of anthracite consumed per hour per gross effective horse power	3·476	4·122
Pounds of combustible consumed per hour per gross effective horse power.........	2·801	3·453
Mean speed of vessel per hour in geographical miles of 6,086ft.	11·737	9·869
Mean temperature in degrees Fahr. of the atmosphere on deck	38·55	41·00
Mean temperature in degrees Fahr. of the engine room...	64·34	63·52
Mean temperature in degrees Fahr. of the fire room	90 27	98.65
Mean temperature in degrees Fahr of the injection water	34·00	34·00
Mean temperature in degrees Fahr. of the discharge water	61·03	57·18
Mean temperature in degrees Fahr of the hot well or feed water	100·72	112·91
Difference between the rotary speed of the centre of pressure of the paddles and the speed of vessel, in per centum of the former	20·48	22·93

ROYAL GEOGRAPHICAL SOCIETY.

"ON THE EFFECTS OF THE DESTRUCTION OF FORESTS IN THE WESTERN GHAUTS OF INDIA ON THE WATER SUPPLY."

By Mr. C. R. Markham.

The paper contained the results of observations made by the author during a recent visit to the Cinchona plantations on the Neelgherries and other mountains of Southern India. These mountain districts contain the sources of a water-supply on which the prosperity—indeed, the very existence—of millions depends. The most northern part of the range is comprised in the two Mysore districts of Nuggur and Munjerabad, and it is continued through Coorg, Wynaad, and the Neelgherries, to the remarkable gap at Palghat, which enables the railroad to pass from sea to sea, and, beyond the gap, comprises the Anamallay, Pulney, and Travancore hills. The rainfall along this range is derived almost exclusively from the south-west monsoon between May and September; but the amount decreases as Cape Comorin is approached. Near Bombay it is 248in., while at the capital of Travancore it is 65, and at the Cape only 30in. The clouds, heavily charged with moisture from the Indian Ocean, part with it on first entering the colder stratum caused by the mountains; the rainfall sensibly diminishing eastward across the plateau, and being curiously affected by the smallest variations of aspect and shelter. Within the last twenty years a great change has come over these forest-clad mountain districts, in the establishment of many English planters, who have brought great material blessings to the natives, but, in the extensive clearings of trees which they have necessarily made, have brought about a deterioration of the climate. In all, a total area of 180,000 acres of forest has been cleared for coffee, tea, and cinchona plantations. One effect of this has been the occurrence of sudden floods, which have increased yearly in volume and destructiveness. There is a system of forest conservancy in the Madras Presidency, and the present Superintendent, Dr. Cleghorn, is a zealous and able man, but Mr. Markham did not advocate Government interference with the development of plantations; he looked for help rather to the formation of reservoirs in the hill districts to regulate the supply of moisture to the great plains in the East, which depend for their habitability on their rivers and irrigation works, fed by the mountain rains. The Cinchona plantations, when grown up, would compensate, to a great degree, for the destruction of the forests, the shade of the trees preserving the moisture beneath them. The storing of water in reservoirs can be effected at the rate of about £100 of capital for a million cubic yards of contents, besides what would be drawn off and again replaced during the monsoon. A discussion of some length followed the reading of this paper, in which Sir William Denison, late Governor of Madras, General Torrens, General G. Balfour, Mr. John Crawfurd, Sir Henry Rawlinson, Mr. Lee, and the president, took part. Sir W. Denison said he had been informed by the collector of the district that the limit of the rainfall, near the great gap in the Western Ghants, had receded seven miles in consequence of the forests having been cleared away. Sir William also gave high praise to Mr. Markham for the great public benefit he had conferred by transporting cinchona-trees from Peru to India, where they were now in a flourishing condition.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last ordinary monthly meeting of the Executive Committee of this Association was held at the offices, 41, Corporation-street, Manchester, on Tuesday, June 5th, 1866, Hugh Mason, Esq., of Ashton-under-Lyne, Vice-President, in the chair, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

During the last month 303 engines have been examined, and 509 boilers, as well as four of the latter, tested by hydraulic pressure. Of the boiler examinations, 318 have been external, 7 internal, and 184 entire. In the boilers examined, 203 defects have been discovered, 12 of those being dangerous.

Tabular Statement of Defects, Omissions, &c., met with in the Boilers examined from April 21st, 1866, to May 25th, 1866, inclusive.

Description.	Number of Cases met with.		
	Dangerous.	Ordinary.	Total.
Defects in Boiler.			
Furnaces out of Shape	2	13	15
Fracture	2	23	25
Blistered Plates	...	4	4
Corrosion—Internal	1	6	7
Ditto External	3	11	14
Grooving—Internal	...	4	4
Ditto External	...	1	1
Total Number of Defects in Boiler ...	8	62	70
Defective Fittings.			
Feed Apparatus out of order	1	15	16
Water Gauges ditto	1	13	14
Blow Out Apparatus ditto	...	28	28
Fusible Plugs ditto	...	1	1
Safety Valves ditto	...	6	6
Pressure Gauges ditto	...	11	11
Total Number of Defective Fittings ...	2	74	76
Omissions.			
Boilers without Glass Water Gauges	...	9	9
Ditto Safety Valves	...	...	...
Ditto Pressure Gauges	...	1	1
Ditto Blow Out Apparatus	...	2	2
Ditto Feed back pressure valves	...	41	41
Total Number of Omissions	...	53	53
Cases of Over Pressure	...	...	...
Cases of Deficiency of Water	2	2	4
Gross Total	12	191	203

Of some of the defects first enumerated a few particulars may be given.

Furnaces out of Shape.—One case occurred at night time to an ordinary double-furnace Lancashire boiler, when in charge of the watchmau, who, on the engine's stopping for want of steam, went to the boiler to see what was the matter, aud found that the water had gone out of sight in the gauge glass. The fires were at ouce drawn, happily in time to prevent explosion, but not before the furnace crowns were injured so as to need repair. The watchman states that the water was 7in. high in the gauge glass half-an-hour before, and, as the arrangement of the feed apparatus was defective, it is possible that the water may have escaped. This shows the importance of having the feed inlet above the level of the furnace crowns, so that they cannot be syphoned bare, even though the back pressure valve or any other part of the feed apparatus should fail. This arrangement of feed inlet has been frequently recommended in the Association's monthly reports, while this was repeated in written communications addressed to the owner of the boiler.* If, however, the feed was neglected by the watchman, a low water safety valve would have aroused his attention, and also prevented all danger of explosion by letting off the pressure of the steam on the water's falling below the proper level. These simple precautions are recommended to all, but more especially to those steam users who allow their boilers to be worked at night in charge of watchmen. A detailed drawing of the arrangement of feed inlet recommended, lies at these offices for the assistance of the members.

Fractures.—One was met with at the bottom of an ordinary double-furnace Lancashire boiler, where it rent at a transverse seam of rivets for a distance of 4ft. 3in., and through twenty-seven consecutive rivet holes. This was due to the feed water being delivered at the bottom of the boiler, coupled with the mode of setting, by which the flues split at the back instead of at the front, so that the gases from the furnace did not pass underneath the boiler until their heat was nearly exhausted by traversing the side flues, whereas they should have passed under it immediately after leaving the furnace tubes, and lastly along the side flues.†

Corrosion, External.—One case occurred to a horizontal water tube, two of which were attached to the bottom of an ordinary mill boiler, and ran along underneath it for nearly its whole length, so that the general arrangement became somewhat similar to that of a French or Elephant boiler; with this exception, however, that it was fired internally, while the others are fired externally. The horizontal water tube was about 20ft. long, and affected at the side close to the brickwork, the corrosion extending for a width of about 5in. from one end of the tube to the other, the plate being so reduced in thickness that the inspector, on scraping off the oxide, ran his chisel through the metal, and found that he could tear it away almost like a sheet of paper. Fortunately the diameter of the tube was small, and the pressure of the steam low, or explosion would not have been escaped.

A second case was met with in an ordinary double-furnace, internally-fired Lancashire boiler, aud occurred at the side wall on which the boiler was seated, extending from one end of it to the other, and being so dangerous that the boiler had at once to be condemned. The corrosion was caused by damp rising from the bottom flue, accelerated in its influence on the plates by the injudicious mode in which the boiler was set, which, instead of being carried on firebrick blocks, with a bearing surface of about 4in. or 5in., was let down on to the solid brickwork, which had a bearing surface 9in. wide, while the bottom of the external side flues was flat. Thus, moisture from the subsoil rose more readily through the brickwork to the plates, and any water percolating into the side flues drained between the seating and the boiler.‡

Feed Apparatus out of Order.—Feed back-pressure valves need seldom be allowed to rise in their seatings more than half an inch, while they should be frequently taken out, examined, and cleaned, instead of being left to work on until attention is called to their disordered state by the boiler losing its water, and the furnace crowns being damaged. In the present instance the feed back pressure valve had been allowed to work on until the brass seat was loosened and lifted out of its place, when both it and the valve rolled uselessly about in the feed box. Had explosion arisen from this simple cause, the result would doubtless have been considered mysterious.

"Entire" Examinations.

It is gratifying to find that, since the adoption of the Guarantee principle, the number of internal and flue examinations is steadily increasing. In the preceding table it will be seen that 7 boilers were examined "internally" and 184 "entirely" during the past month, which is the highest return since the commencement of the Association. During Whit week, when the mills were stopped for the holidays, the staff of inspectors, as well as office assistants, made as many flue examinations as possible, and succeeded in attending to all with the exception of three. The pressure, however, at these general holidays is so great that it is urged upon the members to make use of the holidays peculiar to their own locality, which happen at different times in different parts of the country. When the office assistants turn out to make flue examinations, the issue of the reports to the members must necessarily be for a time deranged.

Explosions.

Three explosions have occurred during the past month, by which two persons were killed, and three others injured; in addition to which four men have been scalded to death with steam and hot water, three of them from the fracture of a blow-out pipe at the bottom of a boiler. Not one of the boilers in question, was under the charge of this Association. The following is a tabular statement:—

Tabular Statement of Explosions, from April 21st, 1866, to May 25th, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
20	April 22	Particulars not yet fully ascertained	0	0	0
21	April 26	Small Portable. Internally-fired	2	2	4
22	May. 25	Particulars not yet fully ascertained	0	1	1
		Total	2	3	5

No. 21 Explosion is an illustration of the importance of boiler equipments, and shows that this subject does not always receive due attention. The explosion occurred at a colliery, at a quarter past six o'clock on the evening of Thursday, April 26th, to a boiler not under the charge of this Association, and resulted in the death of two men, as well as injury to two others.

The boiler, which was a small portable one of vertical construction, and internally-fired, was employed for winding at one of the colliery pits, having an engine of about four-horse power attached to it, the whole being complete on one frame, and without any external brickwork flues. The size of the boiler was quite diminutive, which it is important to note in connection with the fatal results of the explosion. Its height was only 5ft. 3in.; its diameter 2ft. 4in.; while the thickness of the plates was about a quarter of an inch, and the pressure at which the valve was stated to be loaded was 80lb. on the square inch, the boiler having been warranted by the makers as safe at upwards of 150lb. What the actual pressure had been, it was difficult precisely to ascertain, after the explosion, but on carefully testing the safety valve both, with dead weights and hydraulic pressure, as well as from a consideration of the evidence given at the inquest, there seem no grounds to conclude that the load upon the safety valve had been excessive for a boiler of such dimensions, if well made and suitably equipped, which, however, did not prove to be the case, as will be seen from the following:

The manhole, which was cut in the cylindrical portion of the boiler, was not strengthened with any mouthpiece, the importance of doing which has been so repeatedly attention to in previous reports, and particularly in the one for April last, in which five explosions were referred to, all of which arose from unguarded manholes.* Such was the case in the present instance. The boiler failed at the manhole, from which three rents started; and, diverging in different directions, rent the boiler open from the top to the bottom, and running round one ring seam of rivets at the crown, and another at the base, completely stripped off the whole of the external shell, and tore it into fragments, though some of the small pieces into which the shell was broken up were, perhaps, due to the blow the plates received on falling to the ground after the explosion. The manhole cover and the shell of the boiler were blown in opposite directions, the former to a distance of about 28yds., and the latter 130.

The omission of the manhole mouthpiece, however, was not the only defect in the equipment of this boiler, since it was fitted with but a single safety valve, and that of the most dangerous construction. This safety valve, which was $1\frac{1}{4}$in. in diameter, was loaded with a spiral spring of so stubborn a character that it was found, on carefully testing it with hydraulic pressure after the explosion, that one turn of the nuts which held it down in its position was sufficient to raise the pressure from 80lb. to 150lb., while a second turn raised it from 150lb. to upwards of 200lb., so that there was but a turn of the nuts between safety and explosion, or a single thread between life and death. So stubborn a spring as this would never admit of a free escape, and though the steam might just wheeze at the stated blowing-off point of 80lb., yet the pressure would rapidly rise on blowing-off freely. Added to this, the mode of securing the spring was most objectionable. It was held down in its position by a couple of ordinary nuts, operating on a cross head carried by a couple of pillar bolts, on to which the nuts were screwed; but there were no collars on these bolts, neither were there any ferrules slipped over them to prevent the nuts being over screwed, and thus of the pressure being increased either by accident or design, although, as just shown, the precise position of the nuts was of so much importance.† It would frequently be the engineman's duty to take out the safety valve to clean it and grind it up, and in order to do this the nuts securing the spiral spring

* See Association's Monthly Reports for March, 1864, January, 1865, December, 1865, and January, 1866.

† See Monthly Report for August, 1863, containing remarks on the best method of setting internally-fired boilers, and giving drawing of external brickwork flues.

‡ See remarks on the setting of the boiler that exploded on the 27th of March last, under the head No. 16 Explosion in the monthly report for April, 1866, and also particulars of seating blocks given in monthly report for August, 1863.

* The danger of these unguarded manholes has frequently been pointed out in private reports written to the members, as well as in the Association's printed monthly ones, and several explosions due to this cause recorded. These may be thus enumerated:—One, No. 2 explosion, February 6th, 1863; a second, No. 3 explosion, 1865, January 9th; a third, No. 5 explosion, 1865, February 6th; a fourth, No. 43 explosion, 1865, December 12th; a fifth, No. 14 explosion, 1866, March 13th; while full particulars of each of these were given in the monthly reports for February, 1863, January, 1865, November, 1865, December, 1865, and April, 1866, respectively.

† An explosion occurred to a portable multitubular boiler on the 18th of January last, through the omission of one of these ferrules.—See explosion of No. 6, in the Report for January, 1866.

would have to be taken off, when it would be a matter quite of hapbazard iu replacing them, wbether, with so stubborn a spring as this was, the valve was screwcd down to a pressure of 100lb. or 200lb. The arrangement was altogether a most dangerous pitfall, aud the valve quite unfit to be used at all, but more especially to be the only one upon a portable boiler, which is as a rule worked by men of but average ability, aud who though they may be careful are not mechanics.

At the inquest the jury did uot fail to appreciate the dangerous equipment of this boiler, and gave in their verdict 'that the explosion resulted partly from the defective coustruction of the boiler, in not having a mouthpiece to the man-hole, and partly from the defective construction of the safety valve.' Were there more of such clear and straightforward verdicts there would be fewer explosions, and since portable engines are now ccming into such general use all over the conntry, it is of importance that the facts of this explosion, which is by no means an isolated case, should be widely circulated, so that attention may be drawn to the importance of equipping these boilers with more simple and efficient fittings, especially when it is remembered to what class of men such boilers are by necessity usnally entrusted. It is hoped that the fact of two meu having beeu killed by this explosion, coupled with the clear verdict of the jury, will induce the makers of this boiler not to turn out any others cquipped as this oue was, which, though warranted by them as safe at upwards of 150lb. on the square inch, burst at a lower pressure before it had done six months' work.

Before concluding the remarks on this explosion, it may perhaps be permitted to suggest to the makers of portable boilers the importance of adopting a simple and efficient dead weight safety valve. There may be a difficulty in applying internal dead weight safety valves from want of room, bnt there is a descriptiou of external dcad weight valve, many of which are under inspection, that seems well adapted for portable boilers. In tbis valve the weight is in the form of a hollow cylinder, whicb drops over the seat, aud is suspended from it, so that it is pendulous in its action, and having neither spindle nor wing to become bound in tbe seating, it does not appear possible for it to stick fast. It can be placed, as stated, outside the boiler, and tbus in view, so that it could not be over-weighted without detection. A number of these valves are at work under thc inspection of this association, they are found to give every satisfactiou, and it is thought that if all portable boilers were fitted with them many explosions would be prevented.

THE ROYAL SOCIETY.

NOTE ON THE AMYL-COMPOUNDS DERIVED FROM PETROLEUM.

By C. Schorlemmer.

In a former communication I have shown that the bydride of heptyl obtained from petroleum has a higher specific gravity than isomers ethyl-amyl, and hydride of heptyl from azelaic acid. The same is thc case with their derivatives, and some of these isomeric compounds also show considerable differences in their boiling-points.* I could not compare the different heptyl-compouuds which I prcpared with those of heptyl-alcohol formed by fermentation, as the latter substance is very little known, and I therefore considered it interesting to compare the amyl-compounds from fusel-oil with those obtained from petroleum. From the latter substance I prepared a considerable quantity of pure hydride of amyl, which boiled constantly at 33°–35° C.; and I did not succeed in lowering the boiling-point auy furtber. From this hydride other amyl-compounds were obtained in exactly the same way as the heptyl-compounds. Pure amyl-compounds from fusel-oil were also prepared with the greatest care, and their specific gravities and boiling-poiuts compared, under exactly the same circumstances, with the compounds prepared from petroleum. The results of this investigation are coutained in the following table:—

Amyl-Compounds.

	From Fusel-oil.		*From Petroleum.*	
	Boiling-point.	Specific gravity.	Boiling-point.	Specific gravity.
$C_5 H_{12}$	...	...	34° C.	0·6263 at 17°
$C_5 H_{11} Cl$	101° C.	0·8750 at 20°	101° C.	0·8777 at 20°
$\left.\begin{matrix} C_5 H_{11} \\ C_2 H_3 O \end{matrix}\right\} O$	140° C.†	0·8733 at 15°	140° C.	0·8752 at 15°
$C_5 H_{12} O$	132° C.	0,8148 at 14°	132° C.	0·8199 at 14°.

It appears from this table that the boiling-points of the same compounds agree perfectly, and that the specific gravities show only very small differences, those of the substances obtained from petroleum being a little higher. This is easily accounted for by an admixture of higher boiling compounds, which towards tbe end of the distillation raise the boiling-points a little, and which cannot be rcmoved completely, even by long-continued rectifications. The amyl-compounds from petroleum and thosc from fusel-oil are therefore ideutical.

ON A NEW SERIES OF HYDROCARBONS DERIVED FROM COAL-TAR.

By C. Schorlemmer.

The light oils obtained by the destructive distillatiou of cannel-coal at a low temperature, contain, besidcs the hydrocarbons of the marsh-gas and benzol series, other substances, which are attacked by concentrated sulphuric acid. If the oil, which has beeu repeatedly shaken with this acid, be subjected to distillation, the hydrocarbons which are unacted upon volatilise first, and a black tarry liquid, equal in bulk to about half the crude oil, remains behind.* On heating this rcsidue more strougly, a brown oil, having an uupleasant smell, comes over at about 200° C.; the temperature rises gradually up to 300° C., and at last a black pitchy mass is left in the retort. Even after repeated rectificrtions the oil always leaves a solid black residue behiud, and it was only by continued fractional distillatious over solid caustic potash and metallic sodium, tbat I succeeded in isolating substances possessing nearly a constant boiling point and volatilising almost completely. The compounds which I thus obtained from cannel-coal oil, boiliug below 120° C., are hydrocarbons of the general formula $(C_n H_{2n} H_{n2-2})_2$, as the followiug analysis and determinations of the vapour-densities show:—

(1) $C_{12}H_{20}$ boiling-point 210° C.

(*a*) 0·262 substance gave 0·840 carbouic acid and 0·290 water.

(*b*) 0·1978 substance gave 0·635 carbonic acid and 0·2195 water.

	Calculated.		Found. *a.*	*b.*
C_{12}	144	87·8	87·44	87·55
H_{20}	20	12·2	12·30	12·32
	164	100·0	99·74	99·87

Globe with air	5·547
Temperature of air	17° C.
Globe with vapour	5·730
Temperature on sealing	250° C.
Capacity of globe	65·0 cubic centims.

Calculated.	Found.
6·68	6·98

The residue in the globe had a browu colour, the oil not being completely volatile; this accounts for the difference betweeu the calculated and found vapour-densities.

(2) $C_{14} H_{24}$ boiling-point 240°.

0·107 substance gave 0·343 carbonic acid and 0·1195 water.

	Calculated.		Found.
C_{14}	168	87·5	87·42
H_{42}	24	12·5	12·40
	192	100·0	99·82

(*a*)	Weight of globe	3·354
	Temperature of air	10°·5 C.
	Globe with vapour	3·5745
	Temperature ou sealing	280° C.
	Capacity of Globe	67·6 cub. centims.
(*b*)	Weight of globe	3·286
	Temperature of air	7° C.
	Globe with vapour	3·4665
	Temperature on sealing	270° C.
	Capacity of globe	55·2 cub. centims.

Calculated.	Found. *a.*	*b.*
6·65	7·06	7·02

The liquid remaiuing in the globe had also iu both cases a brown colour.

(3) $C_{16} H_{28}$ boiling-point 280° C.

0·152 substance gave 0·4885 carbonic acid and 0·174 water.

	Calculated.		Found.
C_{16}	192	87·27	87.11
H_{28}	28	12·73	12·72
	220	100·00	99·83

These hydrocarbons are colourless, oily, strougly refracting liquids, lighter tban watcr, and possessing a faint peculiar smell, resembliug tbat of the roots of *Daucus carota* or *Pastinaca sativa.* I have obtaiued them in small quantities only, and could study their reactions therefore only incompletely. They combine with bromine witb a hissing noise, and if the reaction is not moderated, the liquid blackens and hydrobromic acid is evolved; but by keeping tbe substance well cooled, and by addiug the bromiue very carefully, nearly colourless, heavy, oily, sweet-smelling bromine-compounds are obtained, without the formation of hydrobromic acid. These are very easily decomposed by heating: charry matter separates out, and hydrobromic acid is given off even below the boiling-point of water. From the hydrocarbon $C_{14} H_{24}$ alone I obtained a sufficient quantity of thc bromide for analysis.

0·3715 substance gave 0·3605 bromide of silvcr and 0·0123 metallic silver.

Calculated for $C_{14} H_{24} Br_2$.	Found.
45·45 per cent. Br.	43·7 per cent. Br.

As it was impossible to purify the small quantity of bromide, the difference betweeu the found aud calculated quantities is easily accounted for.

Concentrated nitric acid dissolves these hydrocarbons, much heat being evolved; on diluting the acid solution with water, yellow, heavy, thick oily nitro-compounds separate, which have a faint but peculiarly unplcasant smell. By heating these nitro-compounds with tin and hydrochloric acid, a portion is converted into a black tarry mass, and the solution contains a considerable quantity of chloride of ammonium, and a small quantity of a hydrochloratc, which can be obtained as a crystalline deliquesceut mass by evaporating *in*

* Proc. Roy. Soc. vol. xiv. p. 464.

† The boiling-point of acetate of amyl is given very differently by different observers (Cahours found 125°, Landolt 133—134°; Pogg. Ann. vol. cxxii. p. 554). My observation agrees perfectly with that of Wanklyn (Chem. Soc. Journ. (2) iii. p. 30).

* Journ. Chem. Soc. vol. xv. p. 420.

vacuo. On concentrating the solution in the air, decomposition takes place, a violet substance being formed. By adding caustic potash to the solution of the hydrochlorate, a dark oily base separates, which quickly oxidises into a black tarry mass. Platinic chloride produces at first no precipitate in the concentrated solution of the hydrochlorate, but after a few minutes a dark violet tar separates.

I could not succeed in obtaining crystallised double chlorides of tin or zinc.

If these hydrocarbons are heated with a concentrated solution of bichromate of potassium and sulphuric acid, carbonic acid is evolved, a strongly acid liquid, on which an oily layer swims, distils over, a resinous substance remaining in the retort. As I did not obtain any of the pure hydrocarbons in sufficient quantity to study their separate products of oxidation, I took all that remained, together with the intermediate distillates, and the oil boiling above 280 C., which had been previously well purified by rectification over sodium. After oxidation, the distillate was neutralised with carbonate of sodium, the oil being left undissolved. This neutral oil, which has an ethereal smell, and boils between 200° and 300° C., gave on analysis 84·9 per cent. C and 11·8 per cent. H; it consists, therefore, of non-oxidised hydrocarbons, containing a small quantity of an oxygen compound. The solution of the sodium salt was evaporated on the water bath, the residue distilled with diluted sulphuric acid, and the distillate rectified. It smelt strongly of acetic acid, and also slightly of butyric acid. By neutralisation with carbonate of sodium, a crop of crystals of acetate of sodium was obtained, which were converted into the crystallised silver salt.

0·1335 of this salt gave 0·861 of silver.

Calculated for $C_2 H_3 Ag O_2$.	Found.
64·67 per cent. Ag.	64·50 per cent. Ag.

The syrupy mother-liquor of the sodium-salt gave, with nitrate of silver, a white precipitate, which, on boiling the liquid, decomposed with effervescence and separation of metallic silver, showing the presence of formic acid; from the filtered liquid small warty crystals of a silver-salt separated.

0·1314 of this salt gave 0·842 of silver, or 64·1 per cent. Ag.

The mother-liquor gave on evaporation again crystals of acetate of silver.

0·2196 gave 0·1418 silver, or 64·56 per cent.

The volatile acids produced by the oxidation of the hydrocarbons are therefore carbonic acid, acetic acid, formic acid, and perhaps a trace of an acid richer in carbon.

The resinous substance left in the retort is an acid which dissolves in caustic potash, and is precipitated from this solution as a brown greasy substance, easily soluble in alcohol. The alcoholic solution, neutralised with ammonia gave, with nitrate of silver, a white flocculent precipitate of a silver-salt, which dried into a brown resinous mass, not fit for analysis.

As these hydrocarbons were obtained by the action of sulphuric acid on coal tar oils boiling below 120°, and as they differ by $C_2 H_4$, it appears to me almost certain that they are polymers of the hydrocarbons of the acetylene series, $C_n H_{2n-2}$, formed in the same way as diamylene is formed, by treating amylene with sulphuric acid. The products of oxidation are also in accordance with this view.

In order to test this theory, I have made some experiments with the two isomers $C_6 H_{10}$, namely, diallyl and hexoylene. By acting with sulphuric acid on these compounds, I obtained, besides large quantities of tarry matter, polymeric modifications boiling above 200°, having a smell similar to the hydrocarbons described above, giving also similar nitro-compounds; but the quantities which I got were not large enough for a more exact examination.

The sulphuric acid which was used to purify the coal-tar oils contains an organic substance in solution, which can be isolated by neutralising the acid liquid with carbonate of calcium, filtering, evaporating to dryness in the water-bath, extracting the residue with alcohol, and evporating the alcoholic solution. It forms a yellow amorphous mass, which has a faint, bitter, and astringent taste. A substance with exactly the same properties was obtained from the acid which was used to act upon the hydrocarbons $C_6 H_{10}$.

I am at present engaged upon experiments to isolate the hydrocarbons $C_n H_{2n-2}$ contained in coal-tar.

ON THE DYNAMICAL THEORY OF GASES.

By J. Clerk Maxwell, F.R.S. L. & E.

Gases in this theory are supposed to consist of molecules in motion, acting on one another with forces which are insensible, except at distances which are small in comparison with the average distance of the molecules. The path of each molecule is therefore sensibly rectilinear, except when two molecules come within a certain distance of each other, in which case the direction of motion is rapidly changed, and the path becomes again sensibly rectilinear as soon as the molecules have separated beyond the distance of mutual action.

Each molecule is supposed to be a small body consisting in general of parts capable of being set into various kinds of motion relative to each other, such as rotation, oscillation, or vibration, the amount of energy existing in this form bearing a certain relation to that which exists in the form of the agitation of molecules among each other.

The mass of a molecule is different in different gases, but in the same gas all the molecules are equal.

The pressure of the gas is on this theory due to the impact of the molecules on the sides of the vessel, and the temperature of the gas depends on the velocity of the molecules.

The theory as thus stated is that which has been conceived, with various degrees of clearness, by D. Bernoulli, Le Sage and Prevost, Herapath, Joule and Krönig, and which owes its principal developments to Professor Clausius. The action of the molecules on each other has been generally assimilated to that of hard elastic bodies, and I have given some application of this form of the theory to the phenomena of viscosity, diffusion, and conduction of heat in the *Philosophical Magazine* for 1860. M. Clausius has since pointed out several errors in the part relating to the conduction of heat, and the part relating to diffusion also contains errors. The dynamical theory of viscosity in this form has been reinvestigated by M. O. E. Meyer, whose experimental researches on the viscosty of fluids have been very extensive.

In the present paper the action between the molecules is supposed to be that of bodies repelling each other at a distance, rather than of hard elastic bodies acting by impact; and the law of force is deduced from experiments on the viscosity of gases to be that of the inverse fifth power of the distance, any other law of force being at variance with the observed fact that the viscosity is proportional to the obsolute temperature. In the mathematical application of the theory, it appears that the assumption of this law of force leads to a great simplification of the results, so that the whole subject can be treated in a more general way than has hitherto been done.

I have therefore begun by considering, first, the mutual action of two molecules; next that of two systems of molecules, the motion of all the molecules in each system being originally the same. In this way I have determined the rate of variation of the mean values of the following functions of the velocity of molecules of the first system:—

α, the resolved part of the velocity in a given direction.

β, the square of this resolved velocity.

γ, the resolved velocity multiplied by the square of the whole velocity.

It is afterwards shown that the velocity of translation of the gas depends on α, the pressure on β, and the conduction of heat on γ.

The final distribution of velocities among the molecules is then considered, and it is shown that they are distributed according to the same law as the errors are distributed among the observations in the theory of "Least Squares;" and that if several systems of molecules act on one another, the average *vis viva* of each molecule is the same, whatever be the mass of the molecules. The demonstration is of a more strict kind than that which I formerly gave, and this is the more necessary, as the "Law of Equivalent Volumes," so important in the chemistry of gases, is deduced from it.

The rate of variation of the quantities α, β, γ in an element of the gas is then considered, and the following conclusions are arrived at.

(α) 1st. In a mixture of gases left to itself for a sufficient time under the action of gravity, the density of each gas at any point will be the same as if the other gases had not been present.

2nd. When this condition is not fulfilled, the gases will pass through each other by diffusion. When the composition of the mixed gases varies slowly from one point to another, the velocity of each gas will be so small that the effects due to inertia may be neglected. In the quiet diffusion of two gases, the volume of either gas diffused through unit of area in unit of time is equal to the rate of diminution of pressure of that gas as we pass in the direction of the normal to the plane, multiplied by a certain coefficient, called the coefficient of interdiffusion of these two gases. This coefficient must be determined experimentally for each pair of gases. It varies directly as the square of the absolute temperature, and inversely as the total pressure of the mixture. Its value for carbonic acid and air, as deduced from experiments given by Mr. Graham in his paper on the Mobility of Gases,* is

$$D = 0{\cdot}0235,$$

the inch, the grain, and the second being units. Since, however, air is itself a mixture, this result cannot be considered as final, and we have no experiments from which the coefficient of interdiffusion of two pure gases can be found.

3rd. When two gases are separated by a thin plate containing a small hole, the rate at which the composition of the mixture varies in and near the hole will depend on the thickness of the plate and the size of the hole. As the thickness of the plate and the diameter of the hole are diminished, the rate of variation will increase, and the effect of the mutual action of the molecules of the gases in impeding each other's motion will diminish relatively to the moving force due to the variation of pressure. In the limit, when the dimensions of the hole are indefinitely small, the velocity of either gas will be the same as if the other gas were absent. Hence the volumes diffused under equal pressures will be inversely as the square roots of the specific gravities of the gases, as was first established by Graham †; and the quantity of a gas which passes through a thin plug into another gas will be nearly the same as that which passes into a vacuum in the same time.

(β). By considering the variation of the total energy of motion of the molecules, it is shown that,

1st. In a mixture of two gases the mean energy of translation will become the same for a molecule of either gas. From this follows the law of Equivalent Volumes, discovered by Gay-Lussac from chemical considerations; namely, that equal volumes of two gases at equal pressures and temperatures contain equal numbers of molecules.

2nd. The law of cooling by expansion is determined.

3rd. The specific heats at constant volume and at constant pressure are determined and compared. This is done merely to determine the value of a constant in the dynamical theory for the agreement between theory and experiment with respect to the values of the two specific heats, and their ratio is a consequence of the general theory of thermodynamics, and does not depend on the mechanical theory which we adopt.

4th. In quiet diffusion the heat produced by the interpenetration of the gases is exactly neutralised by the cooling of each gas as it passes from a dense to a rare state in its progress through the mixture.

5th. By considering the variation of the difference of pressures in different directions, the coefficient of viscosity or internal friction is determined, and the

* Philosophical Transactions, 1863.

† "On the Law of the Diffusion of Gases," Transactions of the Royal Society of Edinburgh, vol. xii. (1831).

equations of motion of the gas are formed. These are of the same form as those obtained by Poisson by conceiving an elastic solid, the strain on which is continually relaxed at a rate proportional to the strain itself.

As an illustration of this view of the theory, it is shown that any strain existing in air at rest would diminish according to the values of an exponential term, the modulus of which is $\frac{1}{5100000000}$ second, an excessively small time, so that the equations are applicable, even to the case of the most acute audible sounds, without any modification on account of the rapid change of motion.

This relaxation is due to the mutual deflection of the molecules from their paths. It is then shown that if the displacements are instantaneous, so that no time is allowed for the relaxation, the gas would have an elasticity of form, or "rigidity," whose coefficient is equal to the pressure.

It is also shown that if the molecules were mere points, not having any mutual action, there would be no such relaxation, and that the equations of motion would be those of an elastic solid, in which the coefficient of cubical and linear elasticity have the same ratio as that deduced by Poisson from the theory of molecules at rest acting by central forces on one another. This coincidence of the results of two theories so opposite in their assumptions, is remarkable.

6th. The coefficient of viscosity of a mixture of two gases is then deduced from the viscosity of the pure gases, and the coefficient of interdiffusion of the two gases. The latter quantity has not as yet been ascertained for any pair of pure gases, but it is shown that sufficiently probable values may be assumed, which being inserted in the formula agree very well with some of the most remarkable of Mr. Graham's experiments on the Transpiration of Mixed Gases.* The remarkable experimental result that the viscosity is independent of the pressure and proportional to the absolute temperature is a necessary consequence of the theory.

(γ). The rate of conduction of heat is next determined, and it is shown,

1st. That the final state of a quantity of gas in a vessel will be such that the temperature will increase according to a certain law from the bottom to the top. The atmosphere, as we know, is colder above. This state would be produced by winds alone, and is no doubt greatly increased by the effects of radiation. A perfectly calm and sunless atmosphere would be coldest below.

2nd. The conductivity of a gas for heat is then deduced from its viscosity, and found to be

$$\frac{5}{3}\,\frac{1}{\gamma-1}\,\frac{p_0}{\rho_0\theta_0}\,\frac{\mu}{S}'$$

where γ is the ratio of the two specific heats, p_0 the pressure, and ρ_0 the density of the standard gas at absolute temperature θ_0. S the specific gravity of the gas in question, and μ its viscosity. The conductivity is, like the viscosity, independent of the pressure and proportional to the absolute temperature. Its value for air is about 3,500 times less than that of wrought iron, as determined by Principal Forbes. Specific gravity is ·0069.

For oxygen, nitrogen, and carbonic oxide, the theory gives the conductivity equal to that of air. Hydrogen, according to the theory, should have a conductivity seven times that of air, and carbonic acid about $\frac{7}{9}$ of air.

* Philosophical Transactions, 1846.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON RECENT PROGRESS IN THE HISTORY OF PROPOSED SUBSTITUTES FOR GUNPOWDER.

The changes which have been effected in the composition of gunpowder since its first application as a propelling agent, have been limited to small variations in the proportions of its constituents. But the modifications which have from time to time been introduced into the details of its manufacture, *e.g.* the preparation of the ingredients, their incorporation, and the conversion of the mixture into compact masses (grains, &c.) of different size and density, have been sufficiently important and successful to secure the fulfilment by gunpowder, in a more or less efficient manner, of the very various requirements of military science and of different branches of industry.

The characteristics of gunpowder, as an explosive material of permanent character, the action of which is susceptible of great modification, are mainly ascribable to the peculiar properties of the oxidising agent, saltpetre. Frequent attempts have been made to replace this constituent of gunpowder by other nitrates (such as those of sodium, lead, and barium); but, although materials suitable for blasting operations have been thus prepared (such as soda-gunpowder, and barytic powder, or *poudre saxifragine*), all mixtures of this class, hitherto produced, have exhibited important defects, when compared with gunpowder manufactured for propelling purposes.

The well-known oxidising agent, chlorate of potash, which differs from saltpetre only in containing chlorine in the place of nitrogen, is far more energetic in its action upon oxidisable bodies than any of the nitrates. Thus, a mixture of chlorate of potash with charcoal alone, deflagrates as violently as gunpowder, and is far more readily inflamed by percussion than the latter: while a mixture analogous to gunpowder, containing chlorate of potash in place of saltpetre, detonates, violently when struck with moderate force, and acts far too destructively, on account of the rapidity of its explosion, to admit of its safe employment in fire-arms.

Many years ago, a mixture known as German or white gunpowder, and consisting of chlorate of potash, ferrocyanide of potassium, and sugar, was proposed and tried without success as a substitute for gunpowder; and since then many preparations of similar character have been suggested for employment either as blasting and mining agents, or for use in shells, or even for all the purposes to which gunpowder is applied. The most promising of these, claimed as discoveries by Mr. Horsley and Dr. Ehrhardt, are mixtures of chlorate of potash with substances of permanent character and readily obtained, containing both carbon and hydrogen; such as tannic and gallic acids, and some kinds of resins. These mixtures are much less violently detonating than most of the explosive mixtures containing chlorate of potash, while, if well prepared, they are decidedly more powerful, as explosives than gunpowder. For blasting purposes, some of these mixtures probably possess decided advantages over ordinary blasting powder, and possibly they may also be susceptible of employment for sporting purposes; but they are not applicable to fire-arms used for war purposes, because, in order to ensure the requisite uniformity of action, the ingredients must be submitted to proper processes of incorporation, &c., such as are applied to the manufacture of gunpowder; and this treatment would render the mixtures far more violent, and consequently destructive in their action upon fire-arms, than if used in the form of crude mixtures.

A comparatively safe application of chlorate of potash to the production of a substitute for gunpowder was made about six years ago by a German chemical manufacturer, M. Hochstadter. Unsized (blotting) paper was thoroughly soaked in, and coated with, a thin paste consisting of chlorate of potash, finely-divided charcoal, a small quantity of sulphide of antimony, and a little starch, gum, or some similar binding material, water being used as the solvent and mixing agent. The paper was rolled up very compactly and dried in that form. In this manner, very firm rolls of an explosive material are obtained, which burn with considerable violence in open air, and the propelling effect of which, in small arms, has occasionally been found greater than that of a corresponding charge of rifle powder. Moreover, the material, if submitted in small portions to violent percussion, exhibits but little tendency to detonation. But as no reliance can be placed on a sufficient uniformity of action, in a fire-arm, of these explosive rolls, this alone sufficed to prevent their competing with powder. The same description of explosive preparation, differing only from that of M. Hochstadter in a trifling modification of its composition, which is certainly not likely to lead to its greater success, has recently been brought forward in this country by M. Reichen and Mr. Melland.

One or two other much cruder explosive preparations, containing chlorate of potash, alone or in conjunction with saltpetre, have met with some application to blasting purposes. One of these consisted of spent tan, in small fragments, which was saturated with the oxidising agent, and afterwards dusted over with sulphur. When flame or a red-hot iron is applied to this preparation, it deflagrates very slowly and imperfectly; but when employed in blast holes, where it is confined within a small space, it developes sufficient explosive force to do good work. In addition to comparative cheapness, the great advantage of safety was claimed for this material by its inventor, a claim which was substantiated by the partial destruction by fire, on two occasions, of a manufactory of the substance near Plymouth, without the occurrence of an explosion.

The accidental explosions of gunpowder which are occasionally heard of, occur, in most instances, at the manufactories, and in the course of some operation (especially that of incorporation) to which the explosive mixture is submitted. The only means of guarding against, or reducing as much as possible, the liability to the occurrence of these accidents, consist in the strictest attention to the precautionary measures and regulations, which experience has proved to be essential to safety, and which, in spite of the strictest supervision, are unquestionably sometimes overlooked or imperfectly carried out by workmen. Explosions of gunpowder, generally of a serious character, do occur, however, though very rarely, during the transport of the material, or in the magazines where it is stored. The great explosion of a gunpowder magazine at Erith in September, 1864, specially directed the attention of government and the public generally, to the necessity of adopting measures for reducing, as much as possible, the risk of occurrence of such disastrous accidents. Hence, much interest has recently been excited by a well-known method of rendering gunpowder less dangerous in its character, which has been brought prominently before the public by Mr. Gale, and which consists of diluting powder, or separating its grains from each other, by means of a finely powdered non-explosive substance. Attempts have several times been made in past years, to apply to practical purposes the obvious fact, of which nobody acquainted with the nature of gunpowder could be ignorant, that, by interposing between the grains of powder a sufficient quantity of a finely divided material, which offers great resistance to the transmission of heat, the ignition of separate grains of the entire mass may be accomplished without risk of inflaming contiguous grains. In 1835, Piobert made a series of experiments with the view to apply this fact practically, to reduce the explosiveness of gunpowder, and similar experiments of an extensive character were carried on by a Russian chemist, Fadéiff, between 1841 and 1844. These experimenters found that the object in view might be attained by diluting gunpowder with any one of its components; they also employed very fine sand (a substance closely allied in its physical characters to the powdered glass, which Mr. Gale now proposes to use); but the preference appears to have been given to a particular carbon. It was not attempted altogether to prevent the burning of a mass of gunpowder, when a spark or a flame reached any portion, but to reduce the rapidity of combustion so greatly as to prevent the occurrence of a violent explosion. No more than this is accomplished by the employment of powdered glass in the proportions directed by Mr. Gale. Indeed, as the quantity of diluent required to give to different kinds of gunpowder the character of equally slow burning materials, increases with the explosiveness of the particular powder and with the size of its grain, the proportion of powdered glass with which the gunpowder employed in rifled cannon would have to be mixed to render it only slow burning, would be about double the quantity required for almost altogether preventing the ignition of fine-grain powder, or of the comparatively weak blasting powder with which Mr. Gale's public experiments appear generally to have been instituted. Although a sufficient dilution of gunpowder may secure such comparative safety to the neighbourhoods of large magazines, or to the crews of merchant vessels in which gunpowder (for blasting purposes, &c.) is transported, as to compensate fully for the inconvenience attending the great

increase of volume of the powder, there is no doubt that such a treatment of gunpowder actually issued for military and naval service would be attended by more than one serious obstacle; such as, the tendency of the powder, unless very largely diluted, to separate from the glass, during transport by land or sea, to so considerable an extent as very greatly to diminish the degree of security originally aimed at; the very great addition which would have to be made to the arrangements for carrying the necessary ammunition, in active service; the necessity for introducing in the field or on board ship, the operations of separating the powder from the glass and transferring it to cartridges and shells (which, whatever sifting and other arrangements were adopted, would be time-taking and very dangerous), instead of preserving the ammunition ready for immediate use; and, above all, the incalculable mischief which would inevitably result from the establishment, in the minds of the soldier and sailor, of an erroneous feeling of security, in dealing with gunpowder, which, however harmless it may, for a time, be rendered, must finally be handled by the men in its explosive form. The extremely rare occurence of accidents with gunpowder, on board ship or in active land service, is mainly due to the strictest enforcement of precautionary regulations, some of which may appear at first sight exaggerated or almost absurd, but which combine to maintain a consciousness of danger and a consequent vigilance indispensable to safety.

One of the the most remarkable materials recently employed to replace gunpowder as a destructive agent, is nitro-glycerine. This substance was discovered by Sobrero, in 1847, and is produced by adding glycerine in successive small quantities to a mixture of one volume of nitric acid of sp. gr. 1·43, and two volumes of sulphuric acid of sp. gr. 1·83. The acid is cooled artificially during the addition of glycerine, and the mixture is afterwards poured into water, when an amber-coloured oily fluid separates, which is insoluble in water, and possesses no odour, but has a sweet, pungent flavour, and is very poisonous, a minute quantity placed upon the tongue producing violent headache, which lasts for several hours.

The liquid has a specific gravity of 1·6, and solidifies at about 5° C. (40° F.); if flame is applied, nitro-glycerine simply burns; and if placed upon paper or metal, and held over a source of heat, it explodes feebly after a short time, burning with a smoky flame. If paper moistened with it be sharply struck, a somewhat violent detonation is produced. Alfred Nobel, a Swedish engineer, was the first to attempt the application of nitro-glycerine as an explosive agent, in 1864.

Some experiments were, in the first instance, made with gunpowder, the grains of which had been saturated with nitro-glycerine. This powder burnt much as usual, but with a brighter flame, in open air. When confined in shells or blast holes, greater effects were, however, produced with it than with ordinary gunpowder; its destructive action is described as having been from three to six times greater than that of powder. The liquid could not be employed as a blasting agent in the ordinary manner, as the application of flame to it from a common fuse would not cause it to explode. But Mr. Nobel has succeeded, by employing a special description of fuse, in applying the liquid alone as a very powerful destructive agent. The charge of nitro-glycerine having been introduced, in a suitable case, into the blast-hole, a fuse, to the extremity of which is attached a small charge of gunpowder, is fixed immediately over the liquid. The concussion produced by the exploding powder, upon ignition of the fuse, effects the explosion of the nitro-glycerine.*

The destructive action of this material is estimated, by those who have made experiments in Sweden and Germany, at about ten times that of an equal weight of gunpowder. Therefore, although its cost is about seven times that of blasting-powder, its use is stated to be attended with great economy, more especially in hard rocks, a considerable saving being effected by its means in the hard labour of the miners, and in the time occupied in performing a given amount of work, as much fewer and smaller blast-holes are required than when gunpowder is employed. The material appears to have recently received considerable application in some parts of Germany and in Sweden; but, in England its employment has been confined to one set of experiments instituted in Cornwall last summer, upon which occasion a wrought-iron block, weighing about three hundredweight, was rent into fragments by the explosion of a charge of less than one ounce of nitro-glycerine placed in a central cavity.

Nitro-glycerine appears, therefore, to possess very important advantages over gunpowder as a blasting and destructive agent, but the attempts to introduce it as a substitute for gunpowder have already been attended by most disastrous results, ascribable in part to some of its properties and the evident instability of the commercial product, but principally to the thoughtlessness of those interested in its application, who appear to have been induced, either by undue confidence in its permanence and comparative safety, or from less excusable motives, to leave the masters of ships, or others who had to deal with the transport of the material, in ignorance of its dangerous character.

The precise causes of the fearful explosions of nitro-glycerine which occurred at Aspinwall and San Francisco will, in all probability, never be ascertained; but they are likely to have due, at any rate indirectly, to the spontaneous decomposition of the substance, induced or accelerated by the elevated temperature of the atmosphere in those parts of the ship where it was stored. Instances are on record in which the violent rupture of closed vessels containing commercial nitro-glycerine has been occasioned by the accumulation of gases generated by its gradual decomposition; and it is at any rate not improbable that a similar result, favoured by the warmth of the atmosphere, and eventually determined by some accidental agitation of the contents of the package of nitro-glycerine, was the cause of those lamentable accidents. The great difficulties attending the purification of nitro-glycerine upon a practical scale, and the uncertainty, as regards stability, of the material, even when purified (leaving out of consideration its very poisonous character and its extreme sensitiveness to explosion by percussion when in the solid form), appears to present insurmountable obstacles to its safe application as a substitute for gunpowder.

The conversion of purified lignin or wood fibre into an explosive substance of the same nature as gun cotton, was accomplished by chemists soon after Schonbein's discovery of gun cotton was made known. Finely divided wood, or sawdust, may, by treatment with suitable agents, be to a very considerable extent purified of substances foreign to cellulose; and, if then submitted to careful digestion in a mixture of the strongest nitric and sulphuric acids, and properly purified, it furnishes a highly explosive material similar to the most explosive gun cotton, and possessed apparently of considerable stability. Captain Schultze, a Prussian artillery officer, who was entrusted by his government a few years ago with the investigation of gun cotton, appears to have come to the conclusion that finely-divided wood offered greater prospect of conversion into a controllable explosive agent than cotton wool. The ultimate result of his investigations has been the production of a "gun-sawdust," the explosive properties of which depend in great measure upon its impregnation with a considerable proportion of an oxidising agent, either saltpetre or a mixture of that salt and nitrate of barium. The wood, having been reduced to a tolerably uniform state of division, is submitted by Captain Schultze to purifying processes, for the separation of resinous and other substances from the lignin, and the product is converted by digestion in a mixture of sulphuric and nitric acids into a very feebly explosive material, which leaves a considerable carbonaceous residue when burnt. This product after purification is impregnated with a sufficient proportion of nitrates to give it rapidly explosive power, the oxidation of the carbon being now almost complete. The objects which appear to be aimed at by Captain Schultze in following this method of manufacturing a wood-gunpowder, are, the production of a more gradually explosive material than is obtained by the most perfect action of nitric acid upon wood fibre, and the possibility of preserving the material in a slightly explosive and therefore comparatively harmless form, until it is required for use, when it may be soon rendered powerfully explosive by impregnation with the nitrates. It is asserted that this powder is considerably more powerful than gunpowder as a mining agent: and that, by its employment in mines, the operators are enabled to return to work sooner than when gunpowder is used, because there is little or no smoke produced by its explosion. The latter is an undoubted advantage which Schultze's powder shares with gun-cotton. Advantages are also claimed for this material when employed in fire-arms, and it is possible that, when applied to sporting purposes, it may compete successfully with gunpowder in this direction also; but its behaviour as an explosive, and the peculiarities of its structure, afford little promise of its advantageous employment in arms for military and naval purposes.

Important progress has been made in the history and the practical application of gun cotton since its study was resumed in this country about three years ago. Very considerable quantities of the material have been manufactured at the works of Messrs. Prentice, at Stowmarket, and at the Government Gunpowder Works at Waltham Abbey; its application to mining and artillery purposes, and to small arms, has been, and is still the subject of systematic experiment, conducted by the Government Committee on Gun Cotton; its employment as a blasting agent is steadily increasing in several important English mining districts; and considerable, though not uniform, success has already attended the employment of gun cotton cartridges for sporting purposes.

The system of manufacture of gun cotton, as perfected by Baron Von Lenk, has undergone but trifling modification in its employment in this country. It has been made the subject of careful investigation by Mr. Abel, and the results furnished by many experimental manufacturing operations, and an examination of the products, have shown that the process of converting cotton into the most explosive form of pyroxilin or gun-cotton, and of purifying the material, have been so greatly perfected by v. Lenk as to render a strict adherence to his simple and precise instructions alone necessary to ensure the preparation of very uniform products, which exhibit in their composition a very much closer approximation to purity than those obtained in the earlier days of the history of gun cotton.

Although the conclusions arrived at by the many chemists who investigated the composition of gun cotton, soon after Schonbein's discovery, varied very considerably, the constitution has been very generally regarded as definitely established by the researches of Hadow, published in 1854. According to that chemist, the most explosive gun cotton has the composition expressed by the formula $C_6H_7N_3O_{11}$ (which was first assigned to the substance by W. Crum, in 1847), and may be regarded as cellulose, in which three atoms of hydrogen are replaced by three molecules of peroxide of nitrogen. The name *trinitro-cellulose* has therefore been assigned to gun cotton, its constitution being expressed by the furmula $C_6 \left\{ \begin{matrix} H_7 \\ 3\ N\,O_2 \end{matrix} \right\} O_5$. Hadow's conclusions have since been confirmed by other chemists, more especially by Redtenbacher, Schrotter, Schneider, who have analyzed specimens of gun cotton prepared under Von Lenk's directions. But a report upon the Austrian gun cotton was published in 1864, by Pelonze and Maury, in which the formula $C_{24}\,H_{36}\,O_{18}, 5\,N_2\,O_5$ is assigned to the product of Von Lenk's process; the conclusions of those chemists being founded partly upon some analytical results, and partly upon the increase of weight which they found cotton to sustain, when submitted to treatment with the mixed acids. They found the greatest increase in weight to be 78 per cent.—a number slightly in excess of that which would correspond to the requirements of the formula which they adopt.

An experimental inquiry into the composition of gun cotton, as obtained by v. Lenk's process, has been instituted by Mr. Abel; and the very numerous analytical and synthetical results which he has obtained, confirm the correctness of the formula assigned by Crum and Hadow to the most explosive gun cotton, and demonstrate satisfactorily that the products obtained by following strictly the instructions given by v. Lenk, are invariably trinitro-cellulose, in a condition as nearly approaching purity as a manufacturing operation can be expected to furnish.

The most explosive gun cotton is perfectly insoluble in mixtures of ether and alcohol; but by varying the proportions and strength of the acids employed for the conversion of cotton, products of less explosive character are obtained,

which are more or less freely soluble in ether and alcohol (furnishing the well-known material *collodion*). If, therefore, in manufacturing gun cotton, the conditions essential to the production of insoluble pyroxilin are not strictly fulfilled, the uniformity of the product will suffer.

The ordinary products of manufacture are never altogether free from soluble gun cotton; but the proportion present is small and very uniform, amounting to about 1·5 per cent. They contain, besides, a small quantity (about 0·5 per cent.) of matter soluble in alcohol alone, and possessed of acid characters, which is evidently produced by the action of nitric acid upon such small quantities of resinous or other matters foreign to pure cellulose, as are not completely removed from the cotton fibre by the purification which it receives.

There appears good reason to believe that this impurity in gun cotton is of comparatively unstable character, and that the great proneness to spontaneous decomposition which has been observed by Pelouze and Maury, De Luca, and others, in some specimens of gun cotton, is to be ascribed in great measure to the existence in those specimens of comparatively large proportions of those unstable bye-products.

One hundred parts of carefully purified cotton wool have been found by Mr. Abel to furnish from 181·8 to 182·5 parts of gun cotton. The increase which perfectly pure cellulose should sustain by absolutely complete conversion into a substance of the formula $C_6 H_7 N_3 O_{11}$ (*trinitro-cellulose*) is 83·3: the above results are therefore strong confirmations of the correctness of this generally accepted view of the composition of gun cotton. In carrying out the actual manufacturing process, as prescribed by v. Lenk, somewhat lower results are obtained, because of impurities existing in the cotton employed, and of loss of product during its purification.

Very extensive experiments are in progress at Woolwich, with the view of examining fully into the extent of liability to change of gun cotton when preserved in store, or exposed for prolonged periods to light and to degrees of heat ranging between the ordinary atmospheric temperatures and that of boiling water. The results hitherto arrived at, though they have shown that, under severe conditions, gun cotton is liable to decompose, have not confirmed the conclusions arrived at by the French chemists, with regard to the great instability of the material. Thus De Luca states that, all specimens exposed by him to sunlight decomposed either on the first day or within a few days. But, at Woolwich, no single instance of such rapid decomposition of gun cotton, made by the present process, has been noticed. A very gradual and slight development of gas occurs after a time when the substance is exposed to sunlight; but the quantity which has been collected from specimens exposed at Woolwich to direct daylight and sunlight for two years and a half, is very small, and the gun-cotton has in all instances preserved its original appearance. Pelouze and Maury state, that gun cotton always decomposes perfectly within a few days, by exposure to temperatures of 55°—60°C. (130°—140 F°.), and they lay great stress upon the explosion of a specimen direcoly it was introduced into a vessel heated to 47°C. (116°·6F.). But, at Woolwich, a specimen of ordinary product which has been exposed now for twelve months to 65°C. (150°F.), has involved only a small quantity of gas, and retains its original appearance perfectly. Several specimens, after having been exposed for some hours to a temperature of 90°C. (194° F.), during which period some nitrous vapours were in all instances evolved, have since been exposed to light in closed vessels for about twenty months, and still retain their original appearance and explosive characters. Several large ammunition cases, closely packed with gun cotton, have been preserved for six months in a chamber, the temperature of which was maintained for three months at 49°C. (120°F.), and afterwards at 54°—55°C. (130°F.), arrangements having been made for periodically registering the temperature within the boxes, which were kept closed. In no instance has the latter temperature risen to an extent to indicate serious chemical change, *i. e.* it has always been below the temperature of the air in the chamber. These few examples of results already obtained are given to show that the behaviour of gun cotton manufactured in England by v. Lenk's process does not, as yet, at all justify the condemnation which the material has recently received in France.

One most important point in connection with the preservation of gun cotton appears to have been lost sight of by the French experimenters. The material may be most perfectly preserved, apparently for any period, either by immersion in water, or, still more simply, by being impregnated with just sufficient moisture to render it perfectly uninflammable. In this condition, gun cotton is much safer than gunpowder can be rendered, even by mixture with very large proportions of incombustible materials. It may be transported with quite as much safety as the unconverted cotton; indeed, it appears to be very much less prone to gradual decay, if preserved for very long periods in a damp condition, than cotton or other vegetable substances. Many specimens of gun cotton, preserved for several months in a very damp chamber, together with paper, cotton fabrics, and wood, retained their strength of fibre and all their original properties, and had no signs even of mildew upon them, while the paper fabrics in immediate contact with them had completely rotted away, and the wood was covered with fungi.

Considerable progress has been made in the manipulation of gun cotton, with the object of modifying its explosive action. The rapidity with which gun cotton burns in *open air* admits of ready and very considerable variation by applying the simple expedients of winding, twisting, or plaiting gun cotton yarn of different sizes. But, although a mass of gun cotton may be made to burn in a comparatively gradual manner by being very tightly wound, a charge of the material in that form acts quite as destructively when exploded in the bore of a gun as an equal charge consisting of the yarn wound very loosely, because the pressure of gas established by the first ignition of the charge renders the compact packing of the gun cotton powerless to resist the instantaneous penetration of flame between the separate layers of the material. The assertion that a power had been acquired of controlling the explosive action of gun cotton in a fire arm by simply varying the compactness with which the material was twisted or wound, has, therefore, proved quite erroneous. There are, however, two methods of reducing the rapidity of explosion of gun cotton, which are much more likely to furnish successful results. The one consists in diluting the material by its admixture either with a less explosive variety of gun cotton or with some inexplosive substance, such, for instance, as the cotton in its original form. The latter mode of dilution has recently been applied by Messrs. Prentice to the construction of cartridges for sporting purposes, and they describe the results already arrived at as very promising. The second method of controlling the explosion of gun cotton consists in consolidating the material by pressure into compact homogeneous masses, and in confining the first ignition of such compressed gun cotton in the bore of the gun, to certain surfaces. The gun cotton fibre in the form of yarn or plait may be compressed into very compact masses by being rammed into strong cylinders of pasteboard or other suitable material; but much more perfectly homogeneous and solid masses are produced, independently of cylinders or other cases, by a method which Mr. Abel has recently elaborated, and which consists in reducing the gun cotton fibre to a fine state of division or pulp, as in the process of paper making, and in converting this pulp by pressure into solid masses of any suitable form or density.

This method of operating affords also special facilities for combining both methods, dilution and compression, of reducing the explosive violence of gun cotton. The material is, in fact, operated upon by this system, in a manner exactly corresponding to the processes by which the explosive action of gunpowder is regulated to so remarkable an extent. Some results, which are admitted by the most sceptical as encouraging, have already been arrived at, in the systematic course of experiments which are in progress, with the object of applying the methods of regulation, pointed out, to the reduction of gun cotton to a safe form for artillery purposes. Its arrangement in a form suitable for small arms is a much less difficult problem, which may be considered as approaching a perfect solution. For employment in shells and for military mines, both land and submarine, the compressed or solid form of gun cotton presents special advantages on account of the great compactness which may be imparted to it; a given weight arranged so as to ignite instantaneously under pressure (*i.e.* in strong vessels), may be made to occupy the same space as an equal weight of gunpowder, whereas the forms of gun cotton hitherto applied to these purposes occupy about three times the space of gunpowder.

Beautiful pyrotechnic effects may be readily produced by means of gun cotton, though the absence of smoke, which in some of its applications (especially in mines), would constitute an important advantage, detracts from some of the effects which may be obtained with pyrotechnic compositions. On the other hand, gun cotton fireworks may be displayed in-doors without inconvenience.

There appears at present no reason to doubt that the application of gun cotton with great advantage to at least some of the more important purposes for which gunpowder is used, will, ere long, be fully established, and that this interesting explosive agent is destined to occupy a permanent and prominent position among the most important products of chemical industry.

WAR, AND THE BEHAVIOUR OF IRON-CLADS IN ACTION.

It is not our province to contemplate the subject of war from a political point of view, nor do we propose more now, than to accept the grim lessons it teaches, when we recognise some interesting facts, which grew out of the attack of the Spaniards on Callao, on the 2nd of May, 1866. The history of this affair is soon told. At eleven a.m. signal was made by the *Numancia*, flag ship, to get under weigh. Soon after, the six frigates, with steam up and topmasts and lower yards down, tripped their anchors and formed line of battle in two columns of attack. The column to engage the northern forts consisted of the *Villa de Madrid*, *Almanza*, and *Berenguela*; the latter leading. Those intended for the western forts were, the *Numancia*, *Blanca*, and *Resolucion*. The gunboat *Vencedora* taking position between the two columns, in order to render assistance, in the event of necessity. At ten minutes past twelve the first shot was fired from battery No. 2, at the *Numancia*, which that ship replied to at once, and in about five minutes the action became general, with both divisions of the fleet. In less than half-an-hour after the action commenced, the *Villa de Madrid* made a signal, and the little *Vencedora* went and towed her out of range. The steam of the *Villa de Madrid*, was at this time seen issuing in clouds from every part of the vessel. In about twenty minutes after this, the *Berenguela* moved slowly out of range. This ship had been receiving a heavy fire from batteries No. 8, 9, and 10; and a cross fire from battery No. 5, and among the many shots which she received, one had evidently penetrated at or under the water line, rendering it necessary to careen that ship to prevent her sinking. The ship's pumps, and even band buckets, were fully employed to get rid of the large quantity of water that had entered. It fact she did not return to her place in the action. At half-past two, the *Blanca* and the *Resolucion* retired to repair damages, but soon returned and remained until the fight was over.

Of the batteries on shore, No. 3 was blown up by some casualty soon after the commencement of the fight. It contained two three-hundred pounder Armstrongs, rifled. These guns were, of course, rendered useless, and every one in the vicinity was killed or wounded. In battery No. 7 the three-hundred pounder Armstrong was dismounted the first fire.

At fifteen minutes past five, the Spaniards ceased firing, and stood out of range. Nothing reliable is known of the exact number of killed and wounded on either side. Bored, as the ships are admitted to have been,

the number of casualties must have been heavy. The shot that disabled the *Villa de Madrid*, penetrated her steam pipe, killed 18 men and wounded 21 men.

Here we find one of the most formidable ships in the Spanish fleet put *hors de combat* by a shot which penetrated her steam pipe. Now, most of these Spanish ships of war have been built in England. Their fitments have been adopted according to general knowledge and experience of these things, yet here is a vital part penetrated, and the formidable ship rendered useless, "in less than half an hour after the action commenced."

It is true that the main body of this little fleet stood "a good pounding" for some five hours, but the batteries which accomplished this task were manned by men of little experience, whilst the most formidable of those batteries was rendered useless by accident at the onset. Spanish pride kept her ships doggedly and uselessly at this work; true heroism might have suggested another course. There were iron-clads in that fleet, but they were not impervious to the heavy concussions of the shot from the batteries. We hope to gather further information on this important point. Much more has been expected from iron-clads, than we ever thought them capable of. Iron may be a valable acquisition to a "monitor," having its exposed surface placed obliquely to the "line of fire," thus reducing the force of impact; but we see quite another condition when we cover an immense and nearly perpendicular surface, such as the side of a first-rate man-of-war, with iron mosaic work. We may not forget the value of the concussions to which these pieces of iron must be repeatedly exposed from the ponderous modern shot-bolts. Such a process must ultimately detach the pieces it cannot penetrate, and thus the whole question is reduced to the simple one of time.

Accident, which is often made the scape-goat of ignorance, can promptly reduce the question of superiority to an absurdity. "In less than half an hour," it can expose valour to the torment of ridicule, by humiliating a gallant crew, in the "towing out of danger," away from honour and from victory. Such are some of the lessons which the world was taught at Callao.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

A crowded meeting of members of this institution took place at its rooms, Doctor's Commons, City, on the evening of Saturday, the 2nd ult., Mr. Joseph Newton, president, in the chair. The principal source of attraction on the occasion was the promised reading of a third paper on the "Development of the Iron Trade," by Mr. James Robertson, of Bankside. The author, after advancing some observations as to the importance and the extensive nature of his subject as compared with the limited amount of time he had been able to devote to its consideration, proceeded to trace what might very well have been termed the history of steam navigation and iron shipbuilding. This was accomplished with much minuteness of detail and considerable literary ability. The early attempts of Miller, Symington, Fulton, and others, to introduce their primitive modes of steam propulsion were recounted at length; their successes, failures, and disappointments, being graphically, and sometimes humourously, alluded to. From the days when the little steam-boat *Antelope* first crossed from the Clyde to Belfast quay down to those when fleets of mighty ships are regularly traversing the Atlantic, and mightier ironclads are prepared to save England, if need be, from invasion, Mr. Robertson related the progress of the steam engine afloat. The screw propeller and the claims of its inventor or promoter, Mr. F. P. Smith, obtained their share of attention or criticism in Mr. Robertson's exhaustive paper, and, indeed, no point of interest in connection with the subject was omitted. The author promised that on a future occasion he would treat upon our iron roads and the locomotive, as further illustrations of the modern development of the iron trade.

On resuming his seat, Mr. Robertson was much applauded, and Mr. D. Campbell then proceeded to say that he thought the reader of the paper was entitled to the thanks of the association for the able manner in which he had treated his subject. He (Mr. Campbell) distinctly remembered the excitement which prevailed in the neighbourhood of Glasgow when the *Antelope* performed her first trips between Belfast and the Clyde. The progress made in steam navigation since that period had been indeed marvellous, and the development of the iron trade consequent upon it was not less so. At present the firm which he represented (Messrs. John Brown and Co.) was engaged in the production of armour plates of no less than 9in. in thickness, and he believed that in this direction the maximum had not yet been attained. After some further remarks, Mr. Campbell proposed formally a vote of thanks to Mr. Robertson for his paper.

Mr. John Briggs seconded the motion, and in doing so, observed that the time had arrived when the society should seriously entertain the idea of having its transactions systematically printed. Many very valuable communications were comparatively lost by the non-observance of such an arrangement, while some of the provincial institutions of a similar nature to their own were setting the London foremen a better example. It was true that the scientific journals of the metropolis were in the habit of giving excellent summaries of their proceedings, but he wished to see full reports of the monthly meetings on the shelves of its library.

The chairman said he had very much pleasure in putting the vote of thanks to the meeting on that occasion. Mr. Robertson had come forward at a very short notice, and thus prevented what would otherwise have been a *hiatus* in their monthly proceedings. By reading his elaborate and comprehensive paper he had rendered an essential service to his fellow members, who also had spurned the material delights of a summer evening out of doors for the purpose of enjoying an intellectual treat within them. As to the historical matters which the reader had, perforce, introduced into his paper, he (the chairman) would testify as to their general correctness. With regard to the introduction of the system of screw propulsion into the navy, and the patronage accorded by the Admiralty to Mr. F. P. Smith—questions which the author of the paper had incidentally mooted—he considered that sufficient praise had not been given either to Mr. Smith or to the late Mr. George Rennie. He (the chairman) had been himself engaged in the fitting up of the gearing for the *Archimedes*, and well remembered Mr. Rennie's persistent endeavours to convince "my lords" of the great advantages of the screw prior to the commencement of the building of that vessel. It would have been well, too, if Mr. Robertson had advanced an opinion of his own as to the peculiar merits of both paddle-wheel and screw, so as to have raised some discussion on that branch of his subject. Our iron roadways and the locomotive deserved a place also in a paper on the "Development of the Iron Trade;" and Mr. Robertson would, no doubt, on a future occasion make amends for the present omission. The vote of thanks having been put and carried by acclamation, Mr. Robertson, in an eloquent and feeling manner, tendered his aaknowledgments, and the meeting ended.

L'EXTINCTEUR.

This is decidedly a very valuable invention for extinguishing fire. We were present, and witnessed several experiments on the 11th inst., at the Cattle Market, Islington, where a large boarded space was floated over with tar and naphtha. This, when ignited, flared up intensely. At the desire of the gentlemen present, the "Extincteur" was applied when the tar burnt fiercely, and it literally swept off all the flame, as the housemaid might sweep the dust off a carpet. Some boards had been placed in an inclined position, to represent an imaginary staircase. The surface was covered with shavings, these were well daubed with tar, and ultimately sprinkled with naphtha, which when ignited burned until the boards were charred into red-hot cinders. At the given signal the "Extincteur" was applied, and with perfect ease the fire was swept out from the bottom to the top, on the liquid coming into contact with the burning material. Then followed other experiments to a similar issue. Perhaps the most interesting was a frame-work of wood, some eighteen or twenty feet long, by about seven feet high; it was divided into stories or compartments, each compartment having a barrel minus the heads, and laying on its sides, for a centre. Each of these barrels was imbedded in shavings and surrounded with pieces of fir-board about 3ft. long, disposed as hollow as possible, and the interstices filled in with fir shavings. The whole affair was liberally "payd" with tar, and bountifully sprinkled with naphtha from a large watering pot. It was no sooner ignited at one end, than the whole was instantly a blaze of fire. The wind was then blowing strong, and in the direction of the barrels. The fire was uniform and the heat became intense, before the "Extincteurs" were brought to bear. Although successful in extinguishing the conflagration, still it was not accomplished with that sweeping decision, and astonishing promptitude, as when the fire was on plain surfaces. This was a decidedly complicated case of fallen and falling incandescent materials, accumulating when exposed to a strong wind then blowing freely on the fire, which fanned every smouldering ember into flame to which the wind had access. We invited the "Extincteur" to a few embers, which by their position were screened from the wind and remained otherwise unnoticed, glowing at a red heat. The liquid was directed on these embers, and, as a schoolboy rubs off the task from his slate, these red embers immediately became black. After watching them for several minutes they continued to remain black without the remotest sign of revivifying.

Thus may be recorded some of the leading facts in these experiments. They invite reflection, and may receive illustration from seemingly subordiuate facts. The fire on the boards which were covered with tar and naphtha, although only ten or twelve feet square, employed *two* of these "Extincteurs." One might have been sufficient, for ought we presume to know to the contrary, the fact is, *two* were employed. So also *two* were employed to extinguish the fire on the imaginary staircase, and *four* were at work at a time on the barrels, &c. From these facts, in the hands of authority and experience, might be inferred the desirableness, if not the *necessity* for these "Extincteurs" to be so arranged throughout a building, that one of them might be near at hand, whilst the others could be promptly forthcoming. We apprehend, that in the promptitude of its application lays the secret of its usefulness, the legitimate source of "L'Extincteur's" success. As for large fires, we know they are not so readily put out; they have, in general, burnt themselves out. When the fire-engine has arrived, then the locality of the origin of the fire is often found to be a more or less hopeless case. Those in command are pleased on finding their best efforts successful in preventing the spread of the fire to adjoining buildings. A bucket of water and a wet mop has often been sufficient to extinguish an incipient conflagration, and saved the immediate, as well as the surrounding property from destruction. Confusion, fright, and fear

together, often obliterate such resources from the memory, but confidence in a resource must stimulate and nerve the will, and prompt immediate application. "There is a time for all things," and the outburst of a fire, may be the proper, if not the only "time" for deriving all the benefit that L'Extincteur is capable of affording; which "time" if neglected to be provided with efficient means, may be the beginning of a disaster which insidiously complicates itself, and entails loss, if not more intense misery on all around.

The apparatus is composed of a metallic case, or shell, sealed when charged and ready for action, and we presume it may remain ready for several months without deteriorating. This case or shell can be conveniently carried on a man's back, having bands for the shoulders. It is charged with definite proportions of water, of carbonate of soda, and of tartaric acid. When thus brought together, the tartaric acid is free to exercise its preferential affinity for the soda which expels its carbonic acid as gas, which is mainly absorbed by the water under the pressure so generated, of 60 to 70 lbs. per square inch, as we tested by an indicator. It is this force which expels the sodaic solution some 30ft. or 40ft., or probably more at the pleasure or discretion of the carrier, who regulates the quantity by means of a tap, which is all that he has to do by way of preparation at a fire. To this tap a flexible hose is attached, and on which a suitable brass nozzle is fixed, by which the fluid can be guided with the utmost ease and accuracy. The escape of the stream might have been arrested by the end of a black lead pencil it was so small. The fluid, after all, is a factitious soda water, and perfectly harmless alike to health and clothing, whilst the carbonic acid and the soda are each well known extinguishers of flame or fire.

THE ANALYSIS OF WATER.

It is held to be more difficult to discover and define the branch of scientific research from which the engineer is exempted by his professional requirements, than to enumerate those with which he must be familiar. The supply of water to our cities and towns is a matter which frequently comes under notice to await the selection and decision of the engineer. We need not expatiate on the importance of this subject from a sanitory, nor from a monetary point of view. These are disposed of by the engineer in due course, so that he may not betray the confidence reposed in him, but rather, by careful study, endeavour to improve his position by increasing his reputation.

Although the analysis of water does not take rank among the difficulties of the profession, yet we have derived some pleasure in the perusal of that part of "The Annual Report of the Registrar-General on the Water Supply of the Metropolis, during the year 1865-66," by E. Frankland, F.R.S., that we shall not hesitate to introduce a portion of it herewith.

Mr. Frankland states that, in conducting the analysis 1,000 cubic centimetres of the water are evaporated in a weighed platinum dish on the water-bath, an accurately-measured quantity of a solution of sodic carbonate, of known strength, having been previously added. The solution used contains 10 grammes of pure, dry, sodic carbonate in one litre of water, and the quantity employed for one litre of the water, under examination is 10 cubic centimetres or ·1 gramme of sodic carbonate.

The evaporation having been completed, the dish is transferred to an oil bath, where it is exposed to a temperature of 120°-130°c (248°-266 F.); it is then allowed to cool under a desiccator, and weighed as quickly as possible, again exposed to the same temperature as before for about half an hour, and these operations are continued until the weight is constant. The weight of the dish, and of the sodic carbonate added, being subtracted from that, thus ascertained, the amount of solid residue in the quantity of water employed is obtained.

The dish containing the residue is now carefully ignited, and maintained at a dull red heat until the organic matter has been burnt off. It is then allowed to cool, and a saturated aqueous solution of carbonic acid added, in quantity varying, of course, according to the amount of calcic and magnesic carbonates present, which is previously determined with sufficient accuracy by means of the soap-test; every decigramme of calcic carbonate is supposed to require 20 cubic centimetres of carbonic acid water.

When sufficient carbonic acid has been added, the dish is dried at the same temperature as before, until its weight is constant. The difference between this last weight and that before ignition represents the amount of organic and other volatile matter in the quantity of water employed. The next step has for its object the determination of the amount of oxygen necessary to oxidise the organic matter, and for this purpose a standard solution of potassic permanganate is used. This is prepared and applied in the following manner:—$\frac{1}{200}$th of the molecular weight of oxalic acid in grammes, viz.: ·6300 grammes of crystallised oxalic acid ($C_2\,H_2\,O_4$, 2aq) is accurately weighed out (after pressing between filter paper), and dissolved in one litre of distilled water, which has been purified by redistillation from potassic prermangate and sulphuric acid. About ·4 gramme of potassic permanganate is now dissolved in another litre of water that has been similarly purified. A quantity of the oxalic acid solution (10 or 20 c.c.) is then accurately measured out into a large flask; the quantity of purified distilled water necessary to make it up to half a litre is added; and 15 c.c. of dilute sulphuric acid (1 vol of acid to 5 of water) mixed with the whole. The permanganate is now added in small quantities at a time, from a burette furnished with a glass stopcock, to the oxalic acid solution, care being taken to mix the liquids well after each addition. A portion of the mixed liquids is then poured into a glass cylinder about 12in. in height, and 1½in. in diameter which is placed on a white surface. If, on looking down this column of liquid, a distinct pink coloration is visible at the expiration of ten minutes, the reaction is complete and the number of c. c. of permanganate used, is compared with the quantity of oxalic acid employed. The ratio of the two quantities having been observed, the strength of the permanganate solution is altered in such a manner that (as nearly as possible) n vols. of oxalic acid solution will require n vols. of permanganate solution to produce the above-mentioned result. This experiment must now be repeated, and the strength of the permangnate altered, if necessary, until the desired result is obtained.

The following is the reaction which takes place in this experiment:—

$$K_2\,Mn_2\,O_8 + 5C_2\,H_2\,O_4 + 3H_2\,SO_4 = K_2\,SO_4 + 2Mn\,SO_4 + 8H_2\,O + 10CO_2$$

One molecule of permanganate oxidises five molecules of acid, and, therefore, if the oxalic acid solution be of the strength of ·63grm. per litre (or ·00063 grm. per c.c.), each c.c. of permanganate solution will contain ·000316 grm. of pure potassic permanganate, as appears by the following calculation:—

Molecular weight of oxalic acid × 5.		Molecular weight of potassic permanganate.		Amount of oxalic acid in 1 c.c.
630	:	316	::	·000630 grm. : X

X = amount of pure permangauate in 1 c. c. = ·000316 grm.

This amount of permanganate represents ·00008 grm. of available oxygen as the following calculation shows:—

Molecular weight of potassic permanganate.	Atomic weight of oxygen × 5.	Amount of permauganate in 1 c. c.
316.	80.	·000316 grm. : X

X = ·00008 grm. = amount of oxygen in one c. c.

A measured quantity of the water to be analysed is now taken (half a litre is a convenient quantity) and 15 c. c. of dilute sulphuric acid of the same strength as that used in standardising the potasic permanganate solution) having been mixed with it, the solution of permanganate is slowly added (exactly as in the experiment described above) until a pink colouration remains after the lapse of ten minutes. If the turbidity of the water, or the products of the oxidation of the organic matter contained in it render the pink colouration undecided. A fresh experiment is made with 250 c. c. of the water, diluted with an equal quantity of purified distilled water. Should the amount of organic matter be small (requiring less than 1 c. c. of the permanganate), a litre of the water is used.

The number of c. c. of permanganate used, is read off, and multiplied by the number that expresses what aliquot part of a litre of the analysed water was employed. The number thus obtained is now multiplied by ·00008 (amount of oxygen in 1 c. c.) and we then have the amount of oxygen necessary to oxidise the organic matter in a litre of the waterr.

The above experiments are best performed by daylight.

The last operation consists in the application of Clark's soap-test which is performed in the ordinary manner. The *permanent* hardness is determined after boiling the water half-an-hour.

THE SUGAR QUESTION.

It might have been the opinion of some of our readers, that we attached undue importance to this subject. The better to undeceive such, we here extract a letter from *The Times*. Of course the view taken is from the commercial point, and describes an effect. We happen to know that the cause of the grievance lays beyond, that is, with the present crude process of manufacture. Refiners are the main purchasers of the imported article. Those who continued to purchase of the planter, are being undersold by other refiners who purchased the cheaper Belgian sugar. The natural result, which we anticipated, is here clearly depicted. We avail ourselves of the opportunity to suggest, for the serious consideration of planters, that it was not the common seventy-three days' credit that gave the planter only a halfpenny in the pound, but *the loss by improper treatment, of as much sugar as the planter sells*, which loss he has to cover by a higher price on what is sold, and leaves the cheaper beet-root sugar in possession of the market, at the expense of all concerned in the dearer cane-sugar. There can be no doubt that such severe lessons as are occurring daily, will induce the planters to submit their present extravagant process of manufacture to revision, or they must give up all idea of profit from sugar-cane growing. We repeat, that cane-sugar may be produced at

a price that can enable it to compete successfully with beet-root sugar. The following is the letter to which we refer:—

"Failures in the sugar trade are now so frequent that West India planters would be extremely obliged to you for some advice respecting the security of their produce. It is insured against the sea and fire; but when it is sold here a credit of seventy-three days is given to the buyer, and if he fails within that time, the planter loses not only the nett proceeds, but likewise the duty to the Government which he has to pay. Some of my sugars were sold to Messrs. Bowman and Son, who purchased them a few days only before their failure, and I shall sustain a heavy loss in consequence, and be compensated by a dividend, I am told, of about a halfpenny in the pound. The merchant is paid a commission of 2½ per cent., and I believe would guarantee the sales for another 2½ per cent., which is called a *del credere* commission. But might not this onerous tax be avoided by several of the leading merchants agreeing to sell for ready money only, or so to modify the credits as to lessen the risk? The example thus set would would soon be followed universally, and I believe the security thus obtained for the planter, would react most beneficially upon all city interests. A credit of seventy-three days was perhaps essential when the facilities of transport and exchange were not as they are now; but now these are so different, should not an antique mercantile regulation be altered to suit our altered circumstances?—PLANTER."

It is asserted that the cultivation of the beet-root pays better than a crop of wheat, or of any other agricultural produce. Fourteen new factories are being erected in the Zollverein for the manufacture of beet-root sugar. Not less than 600,000 tons of beet sugar were produced last year in Europe, and a considerable addition is expected this year, encouraged by the relatively higher price of cane-sugar. We entertain the question, first, because we happen to know that improvements on a solid basis, in the manufacture of cane-sugar can overcome the present difficulties; and secondly, because there have been many thousands of pounds paid by planters every year to engineers, for machinery of first-class description, and we should regret to see that source, from which many of our engineers have derived considerable advantage, dried up.

STEAM SHIPPING.

Among other novelties which floated upon the Thames during the past year, and continues to be an ornament, is a steam-boat, distinguished from other boats by a large open saloon, instead of a "cribbed, confined" cabin. It is open all round instead of "shut in," except when the weather suggests protection. There is a spacious deck above, for those who indulge "the light fantastic toe." This vessel belongs to the Saloon Steam Packet Company, and is named the *Alexandra;* she is 240ft. in length, 22ft. 9in. in breadth, and draws 4ft. 6in. of water. She is of 157 tons, and 140 nominal horse-power. This style of fitting has long since obtained in warm climates, for river navigation, in India, China, and in the Brazils, on the Rhine, &c. Many of our river boats are mainly pleasure boats, and as the word "comfort" is a very important item in the Englishman's vocabulary, so is its applicability wide enough to include all that pertains to pleasure, as well as to business. The experiment has been tried on the Thames, of a pleasure steamer that does reveal all that can interest the pleasure-seeker on the banks of the river, without the inconvenience of a "sun-stroke," or of a "drenched jacket," and we may not be surprised that such an effort to please has been properly appreciated by pleasure-seekers. No less than 130,000 passengers between London Bridge and Gravesend, and the neat little revenue of £7,405 13s. 4d. rewarded the enterprise, which afforded a dividend equal to 12 per cent. per annum. It remains to be told, that all this was accomplished between the 24th June and the 18th October of last year. There are now two other steamers fitted in the same style, intended to run from London Bridge to the upper part of the river. Their dimensions are 150ft. long, 17ft. broad, and to draw 2ft. 3in. of water, with steam up. The engines are each of 60 horse-power, with 27½in. cylinders. No sooner does a new success occur, than we must also have antagonistic competition.

The *Arran Castle*, built in 1864, was bought in the Clyde, and expected to become a formidable antagonist to the *Alexandra*. She was 220ft. 6in. long, 21 ft. broad, and 7ft. 6in. depth in hold. She registered 224 tons; her engines were of 130 nominal horse-power. She had the character of being a remarkably fast boat. Portions of her deck, cabins, masts, &c., were picked up off Portpatrick. These are all the mementos that remain of this splendid steamer. She encountered some heavy weather on her passage from the Clyde to the Thames. It is feared that all on board shared her fate, and perished in the heavy gale of Friday night, the 23rd of March, 1866. She was owned principally by Mr. Alexander Watson, who, with his son, was on board, as was also Captain Brown, who held a smaller share of the vessel.

If our builders will not accept the responsibility entailed by such serious losses, to whom is it due? But that is not all, for the melancholy list of those who have already lost their lives, is being added to every day. Iron has, in a great measure, superseded wood in the construction of ships of every class. We remember the proposition in 1820, and the Admiralty of that day, to stop the clamour of the proposer, ordered him to construct the three masts and bowsprit of iron for a frigate; but no captain could be found bold enough to apply for such "furniture." That bowsprit has for forty years supported the call-bell in Deptford yard. So much for durability. But to return. Shipwrights have been superseded by boiler-makers, at best; and "naval architects" are often men who can make a clean sheer drawing. Without carrying our analysis too far, we may see the disastrous end of the *London* and of the *Nerbudda;* the one built by one of first firms on the Thames, and the other by a firm equally celebrated on the Mersey. We will touch on two points only now. Men desire a quick voyage, yet complain of a ship's proportions. The vessel being too long, say they, and therefore she breaks amidships and founders, is lost. Granted, that there is this weakest part in the iron ship; but why is she so weak? Has the iron ship been left without an equivalent for the waterways, and shelf-pieces, and wales, and thickstuffs, and iron diagonal bracing on the outside of the timbers, and another diagonal bracing crossing the other on the inside of wooden ships? Then there was the deep keel, and the kelsons below; and the deck, with its beams properly secured above, all and each of these strengthening the ship amidships, whilst tyeing the two ends together. These were not so many pieces stuck, or nailed or bolted, or rivetted on, but by superior arrangement and disposal of materials, and of skilful workmanship, they constituted one homogeneous whole, and herein lay the superior advantage of experienced direction and supervision. Do we seek for an illustration we can have it at Portsmouth. There is the old *Comet*, still, or was recently, towing men-of-war in and out of that harbour in any weather. She has been so employed for the past forty years and more, for she is the first steamer ever built in her Majesty's service. They tell us it is not good for trade to build so very well; hence we build so many. How little of professional pride in the superiority of experience do we discover, and how much of a keen grasping after a spurious economy that can enrich one at the expense, it may be, of the lives of the many. Insurance covers at once the commercial loss, and the avarice or stupidity, or low cunning, the miserable cause of that loss, when hundreds of helpless human beings are swept at one fell swoop into eternity as with "the besom of destruction." We repeat, then, the list of the lost is too long for the credit of our builders. It is high time for builders to command respect and preference, by a conscientious effort for excellence, not in parsimony, but in generous superiority of production. The ships of such builders will, at all times, command the confidence and the preference of the public when known. Passengers will prefer them, and underwriters will be satisfied with the minimum premium. 268 vessels were reported as lost in the month of February of this year; if to these we add the 410 on the "lost list" for January, we find a total of 678 vessels gone down in two months. We should not be at all surprised if the rules of the underwriters become more stringent for ship-building and repairing.

INSTITUTION OF CIVIL ENGINEERS.

At the meeting on the 15th inst., the discussion upon Mr. Burnell's paper "On the Water Supply of the City of Paris," occupied the whole of the evening.

After the meeting, Mr. H. Temple Humphreys, Assoc. Inst. C.E., exhibited and explained, with diagrams, an instrument called the Cycloscope, for setting out railway or other curves, without the aid of the transit theodolite, &c. Externally, it somewhat resembled a box sextant. It was composed of two essential parts only, viz.: two plane mirrors, one of which was silvered over the whole of its surface, and the other over one-half of its surface. By a law of physical optics, which was called either combined or successive reflexions, a series of images would be formed in the half-mirror, which were rendered available to set out any curve of any given radius, by applying the eye to an eye-hole in the back of the whole mirror, and at the same time setting the two mirrors at an angle to one another equal to the required tangential angle. Then the several successive reflected images of a ranging rod, for instance, were seen to lie upon the circumference of a mathematically true circle. The curve was then readily set out in the field by simply placing other ranging rods in line with these several images. This could be done by looking through the unsilvered half of the half-mirror, and planting the rods opposite to and overlapping the successive reflexions. No error could arise in the manipulation, and the whole process of setting out a true curve was shortened and simplified. After setting the mirrors to the requisite tangential angle, no further adjustment or support was needed than could be afforded by the top of a ranging rod placed at the commencement of the curve, and shifted occasionally to any stake on the curve, that the limits of distinct vision might require.

DEATH OF MR. WILLIAM BUCHAN.

We regret to have to announce the death by violence, in fact, by an unprovoked murderous assault, of Mr. William Buchan the only son of Mr. William Buchan, the respected chief engineer of her Majesty's ship *Warrior*. It would seem that on Tuesday in Whitsun week Mr. William Buchan, jun., a young man about twenty-one years of age, was proceeding towards his home on the Blackeath-road, when he was compelled to re-

monstrate, and which, we are told, he did very quietly, with some troublesome boys who were throwing stones. A working man, who was passing at the time, interfered and took part with the lads, and ultimately struck Mr. Buchan so terrible a blow as at once to smash in his lower jaw. He followed up his brutal conduct by knocking him down and causing a fracture of the base of the skull. The unfortuuate young man was then left by his savage assailant, and after the lapse of a short time the attention of the police was called to the state to which he had been reduced. The constables had not witnessed the attack which had been made upon their prisoner, for they immediately took him into custody on the charge of drunkenness and incapacity, and he was thereon locked up and allowed to remain in a state of insensibility for the space of several hours, until intelligence could be conveyed to his friends. We are informed that he never recovered consciousness. but died from the mortal effects of blows showered on him by a stranger for a supposed offence.

Here, again, we have another instance of the disgraceful apathy, incapacity, and culpable negligence of the police, in failing to make themthemselves acquainted with the condition of those taken into their custody, and of the circumstances which bring about cases of insensibility. It is perfectly heartrending to hear of the treatment received by this poor young man at the hands of the "protectors of the peace." Doubtless, when he fell into the care of the police, he was perhaps so fatally injured as to be beyond hopes of recovery; still, it would have been some little consolation at least to his mourning parents and relatives to have known that the last moments of their only son were eased by those attentions which his frightfully injured condition necessitated, instead of being simply locked up in a police cell as one incapacitated from excesses.

We are desirous of distinctly contradicting, on reliable authority, a statement which was made by a witness, a butcher at Deptford, upon the prisoner being brought up on remand before the magistrate at the Greenwich police-court on the 12th ult., to the effect that the deceased, when he was seen by the witness immediately preceding the attack, was the worse for drink. We are assured that the unfortunate deceased, who was an exemplary and remarkably steady young man, had been seen but a very few minutes before the time when he was met by the witness above named, perfectly sober.

The following statement by the medical practitioner who attended the unfortunate deceased, gives a fearfully vivid description of the frightful injuries inflicted; and what, therefore, can be possibly said in extenuation of the barbarous conduct of the police in locking up, as drunk and incapable, a victim to brutal violence, who must have evidenced clearly what he was suffering from :—Dr. Prior Purvis said he had attended the deceased. He died on the 1st June, and the witness made a *post mortem* examination. The vessels covering the brain were highly congested. On examining the jawbone he found a fracture a little to the left of the chin. Death was not directly caused by the fracture of the jaw, but the injury to the jaw was caused by external violence, and this violence which occasioned the fracture of the jaw caused other mischief. The injury on the brain was the cause of death. The appearances at the top of the brain led him to believe that the blow given upwards under the chin caused the jaw to be broken, throwing the upper part of the brain bruised against the inner skull, and which injury to the brain was sufficient to account for death.

The prisoner has been committed for trial on a charge of manslaughter, with bail in two sureties of £100.

MONITORS CROSSING THE ATLANTIC.

[The following letter was received by us, upon the above subject, just after our issue for last month. Since which the Monitors have safely reached this country.—ED. ARTIZAN.]

To the Editor of THE ARTIZAN.

SIR,—By letters which I have just received from America, it appears that the *Miantonomoh*, a sister ship of the *Monadnock*, is about to leave that country for England, and may be expected in Portsmouth about the 20th of June. Mr. Fox, the able and energetic Assistant-Secretary of the American Navy, is coming over in the vessel, which at least shows that he has no doubt of the seaworthy qualities of that kind of craft, although the sides are so low that the deck is not eighteen inches above the water. The impregnable character of the monitors, from the lowness of their sides, and the immense thickness of their armour, has long been widely known; but in Europe doubts of their seaworthiness, based on the most superficial considerations, have been persistently propagated, in the idea, perhaps, that the public faith in the excellence of the European type of war vessel would thus be maintainable. These illusions, however, the voyage of the *Monadnock* round Cape Horn, and the intended voyage of the *Miantonomoh* across the Atlantic, will no doubt do something to dispel; and mechanicians at least will not be slow to recognise the superior power and efficacy of the monitor vessels, which in action not one of our iron clads would be able to confront for five minutes, without the most imminent risk of being sent to the bottom. The officers and crews of the monitors are entitled to the highest praise for the skill and courage with which they have conducted vessels of so novel a character over stormy seas and into the hottest fire; and we may all be sure that the naval men of this country will not be slow to appreciate these qualities, and to give their brother blue-jackets a cordial welcome when they arrive.

I am, Sir, your obedient servant,

JOHN BOURNE, C.E.

London, May 31, 1866.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page* 105.)

Numerous analyses have been made from time to time of samples of the Metropolitan and other sewage; and sometimes very important theoretical conclusions, and even propositions for the investment of enormous amounts of capital in utilisation schemes, and anticipations of enormous profits from their adoption, have been based upon the results of a single analysis. Such, however, is the variation in the dilution of the sewage of any one locality at different times, that it is quite impossible to draw any safe conclusions from the results of analysis without carefully taking into consideration the circumstances affecting the dilution at the time of sampling. This is strikingly illustrated by the results given in Table I., in which are recorded the grains of ammonia per gallon, as determined by various experimenters, in samples of the metropolitan sewage, taken at different times and places, and also the estimated value of the total constituents in one ton of the sewage, reckoned according to the number of grains of ammonia per gallon as above referred to.

TABLE I.

Grains of Ammonia per gallon in different samples of Metropolitan Sewage, and estimated value of Constituents in one ton.

Authority.	Name of Sewer.	Time of Sampling.	Ammonia per Gallon.	Estimated Value per ton.
			Grains.	d.
Way	Barrett's Court ...	Day ...	41·28	$10\frac{1}{4}$
	Dorset Square ...	Day ...	17·96	$4\frac{1}{2}$
Letheby ...	The Fleet	Noon ...	5·15	$1\frac{1}{4}$
		Midnight..	8·50	2
	London Bridge ...	Noon ...	6·69	$1\frac{3}{4}$
		Midnight..	8·10	2
	Dowgate Dock ...	Noon ...	10·03	$2\frac{1}{2}$
		Midnight..	3·43	$0\frac{3}{4}$
	Iron Gate	Noon ...	8·13	2
		Midnight..	6·20	$1\frac{1}{2}$
	Paul's Wharf ...	Noon ...	12·01	3
		Midnight..	3.13	$0\frac{3}{4}$
	Whitefriars' Dock ...	Noon ...	5·35	$1\frac{1}{4}$
		Midnight..	3·41	$0\frac{3}{4}$
	Custom House, West	Noon ...	6·25	$1\frac{1}{2}$
		Midnight..	8·17	2
	Custom House, East	Noon ...	7·28	$1\frac{3}{4}$
		Midnight..	15·01	$3\frac{3}{4}$
	Hambro' Wharf ...	Noon ...	7·69	2
		Midnight..	5·69	$1\frac{1}{2}$
	Wool Quay	Noon ...	6.95	$1\frac{3}{4}$
		Midnight..	5·00	$1\frac{1}{4}$
	Tower Dock	Noon ...	10·02	$2\frac{1}{2}$
		Midnight..	7·15	$1\frac{3}{4}$
	Mean	... ...	7·24	$1\frac{3}{4}$
Hofmann & Witt...	Savoy-street	24 hours ...	8.21	$2\frac{1}{10}$

The results given at the head of the table, on the authority of Mr. Way are those of probably the first analyses made of the metropolitan sewage and it is only fair to say that at the time he published them, he expressly

stated that although they showed that there was great manurial value in sewage, yet they could not be taken as in any way affording a measure of that value. It was, however, upon the analysis of the sample of the Dorset-square sewage, showing nearly 18 grains of ammonia per gallon, that Baron Liebig based his calculations as to the value of the metropolitan sewage in 1863; and the advocates of particular sewage schemes, and even members of Parliamentary Committees, have sought to found much upon the results of those analyses.

From the varying circumstances under which the samples analysed by Dr. Letheby were taken, as indicated in the table, it is obvious that the results, though very valuable in that respect, must be considered rather as illustrations of the variation in composition of the Metropolitan sewage at different times and places, and as showing the danger of founding important practical conclusions upon the results of the analysis of an individual sample, than as affording direct evidence as to the average composition of the Metropolitan sewage.

The sample analysed by Messrs. Hofmann and Witt was a mixture of equal portions taken every hour during twenty-four hours of dry weather, and there is no doubt that that sample had better claims to be taken as representing the average dry weather sewage of the Metropolis than any other that had up to that time been collected and examined. It was upon the analysis of this sample that Messrs. Hofmann and Witt, calculating the value of the ammonia, organic matter, phosphoric acid, and potassa, which it contained, estimated that the constituents in one ton of such dry weather sewage would be worth rather over 2d., and, according to the information supplied to them for the purpose of their calculations, the quantity of sewage, exclusive of rainfall, would be about 158,000,000 tons per annum, or scarcely three-fifths as much as that assumed in the estimates of Baron Liebig and Mr. Thomas Ellis, as the total sewage, namely, 266,000,000 tons. Yet, Messrs. Hofmann and Witt's estimate of a little over 2d. for the value of the constituents in one ton of the normal dry weather sewage was taken by Mr. Ellis, in his application for the concession of the Metropolitan sewage, as applying to the whole amount of dilute sewage (inclusive of rainfall and subsoil water), which he estimated would be available for utilization (266,000,000 tons), and his calculations of profit to his company and to the ratepayers were based upon this erroneous assumption.

To conclude, in reference to the results recorded in Table I., attention may be called to the fact that the different samples show a variation of from about 3 to more than 41 grains of ammonia per gallon, representing approximately a difference of from $\frac{3}{4}$d. to about $10\frac{1}{4}$d. for the estimated value of the total constituents in one ton of the sewage.

That the results of an analysis of a sample of sewage of any locality taken without careful reference to the circumstances of its dilution, are not only entirely inadequate as the basis of general conclusions, but may even be utterly misleading, is even more strikingly illustrated by the results next to be considered, which were obtained in the course of an investigation undertaken by the late Royal Sewage Commission.

Three members of the Commission, the late Mr. Henry Austin, C.E., Mr. Way, and one of the authors (J. B. Lawes) were appointed a subcommittee to undertake an investigation on the utilization of sewage, The agricultural experiments were conducted at Rugby, and their management, and the selection, collection, and preparation of samples for analysis, devolved upon the authors, the analyses being made in the laboratory of Mr. Way. The inquiry extended over a period of between three and four years, and involved the application of different quantities of sewage to meadow grass and some other crops; the determination of the amounts of produce obtained; the feeding of fattening oxen and milking cows on the unsewaged and the sewaged grass; and the sampling, and more or less complete analysis, of the soil, of the sewage, of the drainage-water from the irrigated land, of the unsewaged and the sewaged grass, of the milk yielded by the cows fed upon it, &c. It is proposed to embody in the sequel a brief abstract statement of some of the more important facts and conclusions brought out by the experimental inquiry above referred to, and the reader is referred for all fuller details to the Reports of the Commission.*

The mode of collecting samples of the Rugby sewage for analysis was, to take about a quart (from a gauge-tank holding between three and four tons, through which the sewage flowed before passing on to the land), at intervals of about two hours for several days together, well mix the quantity so accumulated, and take a sample of the mixture for analysis. Ninety-three such samples were collected and analysed, the period of collection extending over thirty-one months, from April, 1861, to October, 1863, inclusive. Table II. shows the highest, the lowest, and the average amounts of ammonia and total solid matter which the analyses of these numerous mixed samples indicated.

(*To be continued.*)

* Second and Third Reports of the Commission appointed to inquire into the best mode of Distributing the Sewage of Towns, and applying it to beneficial and profitable uses. 1862 and 1865.

REVIEWS AND NOTICES OF NEW BOOKS.

Experimental Researches in Steam Shipping. By Chief Engineer B. T. Isherwood, U.S. Navy, Chief of the Bureau of Steam Engineering, Navy Department. Vol. II. Philadelphia: W. Hamilton, Hall of the Franklin Institute, 1865.

The subject treated of in the present volume is similar to that of the first part of this work, published in 1863, and noticed in Vol. XXI., page 279 of The Artizan. It is a full *exposé* of the method followed by the author in making experiments on the steam generators of various steamers of the U.S. Navy, and a record of the results derived from those researches. Mr. Isherwood, in his capacity as Chief of the Bureau of Steam Engineering, has had, during the last six years, exceptional facilities for making investigations into the working of steam machinery and generators, for scientific purposes. For some time past the author has given great dissatisfaction in certain American engineering circles, by the alleged "pedantry and exclusiveness," and the disregard of "rising talent" discernible in the discharge of his official duties; but, be that as it may, the profession at large is greatly indebted to Mr. Isherwood for the valuable services he has rendered it, by publishing a systematical and able compilation of data which, but for his connection with the U.S. Navy Department, would in all probability have never been disclosed to the engineering public.

The researches recorded in this volume relate to as many as twenty seven ships of the Federal Navy, giving a full account of experiments made on various kinds of steam generators, by various modes of heating, and with various kinds of fuel. In each case the chief dimensions as well as different views and sections of the respective boilers, superheaters, &c., treated of, are given, and summaries of results appended. It would be idle to enumerate the names of all those ships or endeavour to give a *résumé* of the methods of proceeding, the character of the results, &c.; indeed, the limited space at our command would never suffice to give even an abstract of any individual portion of the work; it is to the latter itself that we must refer our readers, and they will, we have no doubt, gather a copious amount of valuable information from the perusal of the work and the inspection of the twenty-nine plates of illustrations. We will confine ourselves here to directing their attention to a few distinctive features occurring in the introductory part and the account of the experiments.

The preface extends over 100 pages, and contains a developed statement of the principles on which the trials were conducted, as well as many valuable tables on the properties of heated water, of saturated steam, on the results derived from the combustion of anthracite and other kinds of fuel, &c. The table of properties of saturated steam in particular is stated to be an original computation, and "made from original formulæ derived from the latest and most accurate experimental determinations." However, it is based chiefly on the formulæ obtained from Regnault, Fairbairn, and Tate's researches, and differs in many respects from Professor Zeuner's table, which we published in the Artizan, Vol. XXII., p. 122. We shall examine this table, and if found superior to those previously published, reproduce it in a future issue.

A lengthy chapter of the work is devoted to "experiments made in the New York navy yard with a tubular boiler and sea water, to determine the efficiency of tobacco juice as a preventive of scale on the water-heating surfaces of marine boilers." The preparation used in these experiments was "Baird's" composition, but they "failed to determine the efficiency of tobacco juice in the formation of scale, owing to the quality of the bay water between the cities of New York and Brooklyn, which produced only the same insignificant quantity of scale, whether the juice was used or not, *ceteris paribus*." In further trials on board the United States steamship *Niagara*, and the screw transport *Union*, during their regular service at sea, it became apparent that the scale produced, with or without the application of tobacco juice, was the same in quantity, but had, in the former case, less cohesive strength and adhered to the metallic surfaces with much less tenacity than the scale produced when the composition was not used. We think that the result arrived at must, under all circumstances, be utterly disproportionate to the expense involved by the use of tobacco juice; in this country, at least, where the weed is not exempt from taxation, as we supposed to be on the other side of the Atlantic, it would be out of the question to use the ingredient alluded to for similar purposes.

In a latter portion of Mr. Isherwood's work, a succinct account of the U.S. screw gunboats of the notorious "Chippewa" class is given. It will be remembered that Mr. Isherwood's adversaries grounded their censures, amongst others, on the defective results derived from this class of vessels. It may not be uninteresting, therefore, to hear the author's own statement. He says:—

> In 1861, immediately after the breaking out of the Rebellion, the Navy Department constructed in great haste nineteen screw gunboats of the "Chippewa" class, to be employed in blockading and holding the sounds, rivers, and estuaries of the southern coast of the United States. The machinery was designed by the writer; it is precisely

the same in all, and was constructed by contract with the principal marine steam engine building establishments in the United States. The hull was designed by John Lenthall, Chief of the Bureau of Construction; and the nineteen vessels were built by contract from the same drawings and specifications. The maximum speed of these vessels was to be 10 geographical miles per hour. They have been in constant use since their completion, and extensively employed as ocean cruisers, as well as for the particular service for which they were intended. They have proved excellent sea boats, carrying their battery well in heavy weather, and the machinery has been reliable and efficient under every circumstance of weather and usage.

In conclusion we may state that the style in which this work was got up, is most perfect; the printing as well as the copperplates leave nothing to be desired. Both the first and the present volume of Mr. Isherwood's compilation will form a valuable addition to any engineering library.

C. Schiele; Advice to his Brother Inventors in England. His Experiences with numerous Patents for Fans, Turbines, &c., as well as Experiences of some other Inventions, made useful for the general good. (Published by himself, at Frankfort-on-the-Main.)

The author of this pamphlet is an inventor of some notoriety, to whose lucubrations we have had repeated opportunities of drawing the attention of our readers. Indeed, some of Mr. Schiele's inventions are by no means devoid of merit, and the construction of his fans, water-wheels, &c., rests on unfortunate in the practical carrying out of his designs, and has, according very sound and well-considered principles. But it appears that he has been to his own statement, fallen in with men who contrived to deprive him, by fair means or foul, of the fruits of his labours. Having failed in his endeavours in this country, chiefly, we presume, from his want of acquaintance with its laws, manners, and usages, he has retired to Germany from whence he has just sent forth the above pamphlet breathing savage hostility and deadly feud to those individuals who have crossed his purposes, chiefly to "lawyers" and "partners;" and our laws of partnership as well as our patent laws are impugned by the author very vigourously, but by no means judiciously. To him, partners are "garotters," lawyers, "cut-throats;" and according to his view, the institutions of this country are such as to give all rights and privileges to the *bailleur de fonds*, none to the inventor. A few passages extracted *literatim* from Mr. Schiele's pamphlet will show in what style he treats his subject. Having spoken of the embarrassments into which the inventor will be dragged through his connection with his partner, he continues:—

> Now a bill of costs comes, and all preparations for you have been made, for not being able to pay it, and you are a slave—as there ever was one—to the scoundrel who got you so far! Do what you like, you are lost. The worst is submission,—the next is bankruptcy and obligation through all your life, your time and knowledge, the next is leaving the country and leaving your name and good character to the tender mercies of consummate villains—respectable garotters, but preserving your liberty and your chance of a honourable living for you and your family, and the possibility of warning your fellow creatures against falling a sacrifice to similar snares and downright cheatery by such respectable garotters. Now supposing you left the country, or supposing you did not and are really able, notwithstanding all exertions of your oppressors, to find a bare living for you and your family, until you might find an opportunity to make your rights acknowledged or to expose the garotters, and to recover a bit from the deep cut wounds of the hellish designers of your misery. What do you expect you can do? I will tell you:—nothing. There is no law for *you* to be applied, because you cannot reach it.

Now, as to the lawyers:

> I know of a case where a Lawyer, after having been told by an inventor, that he could on account of his means proceed no further in a patent action, pretended (oh infernal hypocrisy), to mean it well with him, and to go on with his own means, (he knew the large capital the opponents had to dispose of). He afterwards—after he had got *reachly* paid—came down upon the inventor at the opportune time with bills of costs, not only for the action that concerned the inventor—but mind reader—for actions the inventor was merely a witness to, nothing else! Keep out of the clutches of Lawyers, inventor, you might as well be in the fangs of tigers and the embrace of serpents.

Mr. Schiele certainly takes a far too gloomy view of the case. In our own experience we have known a great many disappointed inventors, who would complain of the world using them harshly, of the stupidity and obtuseness of mankind at large, and attribute their failures to all imaginable reasons, save the impracticability of their ideas, and their want of experience and *savoir faire*; but nowhere we have found the acrimony of disappointment pushed to a further extent than in Mr. Schiele's pamphlet. The latter is, indeed, quite a curiosity, chiefly as regards its style, diction, and spelling; and it may be worth while to peruse it as a specimen of the Germano-English to which the author resorts, for want of sufficient acquaintance with our own idiom. Yet, notwithstanding its numerou imperfections, this pamphlet contains a good many home truths outward and wholesome admonitions to indigent inventors.

Jasper.—An immense quarry of Jasper has been opened near Saint Gervais, in part of the Mont Blanc range of mountains, by a company who have sent some remarkable specimens to Paris. Some of those specimens are of a beautifully pure red, without veins, somewhat resembling the marble known as the *Rosso-Antico* stone. The new Opera house in Paris is to be ornamented with twelve columns and forty medallions of this stone, for the decoration of the state saloons.

BOOKS RECEIVED.

"A Treatise on the Screw-propeller, Screw Vessels, and Screw Engines, as adapted for purposes of peace and war." By John Bourne, C.E. Parts VIII and IX.

Containing "Historical account of Screw-propeller up to 1858," plates of U.S.S.S. *Dictator*, &c.; also tables on performance of screw vessels.

"Templeton, the Operative Mechanic's Workshop Companion." London: Lockwood and Co., 1866. To be noticed in our next.

CORRESPONDENCE.

A Subscriber (New York).—Yes! you are correct as to the time of Fulton's arrival in this country; but you are decidedly *wrong* in describing Fulton as "*the inventor of steamboats;*" a *practical steamboat* by William Symington, had been constructed, and plyed on the canal between Edinburgh and Glasgow, previously to Fulton's arrival in this country. The subject is one too lengthy for us to here dilate upon, but we refer you, for full information, to a carefully elaborated paper upon the subject, which you will find in the "Proceeding of the Society of Arts," of some years back.

Student (Dublin).—We recommend Dr. Ernst Albans' work on the high pressure steam engine.

M. DUPUY DE LOME.

This gentlemen is being paraded before us, in all the completeness of a naval architect. But what is more, this gentleman is quoted as an authority by Englishmen, who do not deserve to have an authority of their own. However humiliating this may be, still it has all the gravity of truth. Nor is this a new-born fact; for it is more than thirty years since Sir James Graham and his admirals dismissed Sir Robert Seppings, whose whole lifetime had been devoted to his profession, and whose superior practical knowledge was, and is, admitted by all who are able to entertain the question. Sir Robert was looked up to with pride by every shipwright, and he was succeeded by a Captain Symonds, who indulged some notions of construction, which he learnt whilst harbour-master at Malta. Capt. S. elaborated them as best he could, in the Royal Navy, whilst he was its Surveyor. These crude notions were assailed on all hands, at the time, and now every effort is made to forget them, being proved at first by science, and since by experience, to be absolutely worthless.

At this same time there were gentlemen filling official situations in the dockyards, as capable as Mons. de Lôme, who required capable men, not admirals, to appreciate them. Death has kindly removed some, and accident or design dissociated others, whilst a few live on a pension.

It seems that they do these things differently in France; hence they have a Dupuy de Lôme.

TESTIMONIAL TO W. J. L. K. JAMIESON.

It is at all times a source of pleasure to recognise the success of engineers, particularly those who leave *comfort* and *home* for other lands, where neither of these significant words enjoy an English value. Our private correspondence from Taboga of the 5th May is confirmed by the *Panama Star and Herald*, and each appears desirous of rendering a meed of praise to Mr. John L. K. Jamieson, after his ten years, an age in that climate, superintendance of the engine department of the Pacific Steam Navigation Company's Staff and affairs. The employées presented to Mr. Jamieson a very feeling, a parting address, recording their past cordial intercourse, and inviting future happiness, welfare and prosperity, for himself and family. It was neatly engrossed on parchment. A trifle, more substantial, took the shape of a dinner service, which cost £270. The *Star* pronounces the occasion to have been "a splendid entertainment," adding "the company lose the services of a most valuable engineer." Mr. Jamieson has been mainly instrumental to the successful working of Messrs. Randolph, Elder, and Co.'s double cylinder engines, since 1856. These engines are now supplied to all the steamers of the Pacific Steam Navigation Company, whereby an immense saving of fuel is effected, compared with the consumption of the engines formerly employed by the company. The large saving indicated, is of considerable importance here where coals are cheap, how much more important must the economy therefore be at Taboga and other places distantly removed from the sources of coal supply. The difference possibly may be the value of a handsome dividend for each shareholder.

PRICES CURRENT OF THE LONDON METAL MARKET.

	May 26.			June 9.			June 16.			June 23.		
COPPER.	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	96	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$
„ tubes, do.	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$
Sheathing, per ton	91	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsb, in London, per ton	7	10	0	7	10	0	7	2	6	7	2	6
Nail rods, do.	8	7	6	8	7	6	8	5	6	8	5	6
„ Stafford in London, do.	8	15	0	8	15	0	8	10	6	8	10	6
Bars, do.	8	15	0	8	15	0	8	10	6	8	10	6
Hoops, do.	9	15	0	9	15	0	9	10	6	9	10	6
Sheets, single, do.	10	7	6	10	7	6	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	15	0	2	11	0	2	13	0	2	13	0
LEAD.												
English pig, ord. soft, per ton	21	5	0	21	5	0	21	0	0	21	0	0
„ sheet, do.	21	15	0	21	15	0	21	10	0	21	10	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	20	5	0	20	5	0	20	0	0	20	0	0
BRASS.												
Sheets, per lb.	0	0	9	0	0	9	0	0	9	0	0	9
Wire, do.	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	13	0	1	13	0	1	13	0	1	10	0
IX „ „ „	1	19	0	1	19	0	1	19	0	1	16	0
IC „ 2nd qua., „	1	11	0	1	11	0	1	11	0	1	8	0
IC Coke, per box	1	6	6	1	6	6	1	6	6	1	4	0
IX „ „	1	12	0	1	12	6	1	12	6	1	10	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Directors' Misrepresentations.—Where a person has been induced to take shares in a Company on the faith of representations contained in the prospectus, which afterwards turned out to be false, the Court of Chancery will grant an injunction to restrain proceedings at law to enforce a call. Vice-Chancellor Wood did so in the case of Smith *v. the Reese River Silver Mining Company* upon an application to restrain proceedings at law to enforce a call of £1 a share on the shares held by the plaintiff in the Company's undertaking, on the ground that he had been induced to purchase the shares by the misrepresentations contained in the original prospectus, which set forth that the Company had contracted to purchase a certain very valuable mineral property of fifty acres, that the vendor had made a large fortune from working adjoining mines, and that he was willing to receive the whole of the purchase-money in paid-up shares of the Company. After the plaintiff had had the shares allotted to him on his application, and had paid the necessary deposit, it turned out that the representations as to the contract having been entered into, and as to the value of the property, were untrue. Hence these proceedings, and the order of the Vice-Chancellor to the effect above stated.

Railway Liability.—In the case of Lunt *v.* the London and North-Western Railway Company, the Company's line of railway crossed a public road on a level at a spot where a private way from a yard communicated with the public road. There was but one gate erected by the Company across both the public and private way, under the control of their gatekeeper. The plaintiff's carman, with his team, on leaving the yard, called out to the gatekeeper to know if the way was safe, so that he could cross the line, and the gatekeeper replied, "Yes; come on." They went on, and the team were run into by the train. It was held by the Court of Queen's Bench that the Company were liable for the gatekeeper's negligence.

Illegal Calls on Mine Shares.—In the case of Watson *v.* Tom, the decision of the Vice-Warden of the Stannaries Court, dismissing the purser's claims for costs in arrear, was grounded on the fact, that the calls in respect of which the suit was instituted had been made at meetings at which there was not represented a majority in value of the share of the mine. The calls in question were made in March, July, and October, 1865, and at one of these meetings only 132 shares were represented out of the 6,000 into which the mine is divided. In the course of the hearing of the case the Vice-Warden remarked:—"He had always held that it was necessary, for the security and protection of the shareholders who were unable to attend a meeting, that a majority in value of the shares in the mine should be represented. That rule he found established when appointed to the office he then held, and he did not see any ground for departing from it in the present case. Were this rule not to be acted upon, a few of the shareholders might meet and make a call, and then doctor the books as they liked, allowing transfers of shares to stand or not as they pleased. Therefore, on this part of the case, he did not feel called upon to depart from the sound rule that had been established in that Court." We cannot say that the rule laid down by his Honour is an unsound or unreasonable one; but we believe we are correct in stating that one-half of the mine meetings at which calls are made the rule is not observed. It is, therefore, of the first importance that mine pursers should take care in future, that when calls are made, a majority in value of the shares is represented at the meeting, or the call may be afterwards resisted by some absent shareholder, and a great deal of trouble and expense be thrown upon the company.—*West Briton.*

Railway Compensation.—The owner of property required by a railway does not lose his right to have the value assessed by a jury under section 23 of the Lands Clauses Act, because he has made no claim, and because the Company have proceeded under section 85. They must have actually paid or tendered the money, or the owner may claim to go in under section 23 or 68. The Court of Queen's Bench thus decided in the case of The Queen *v.* the Metropolitan Railway Company.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Magnetic Iron.—M. Griess has discovered a new source of magnetic iron in the shavings of iron and steel, and especially the long spirals produced on the lathe, which are highly magnetic, especially in the case of soft iron. This magnetism is permanent, and M. Greiss has observed that the south pole is always at the end which is first touched by the tool.

A New Anæsthetic.—Dr. Bigelow, of Boston, announces that he has procured a new anæsthetic which he calls "rhigolene." It is a preparation of petroleum naphtha, boiling at 70° Fahr., and having a specific gravity of 0·625. Dr. Bigelow was led to make his experiments by Dr. Richardson's production of anæsthesia by freezing, through the agency of ether vapour, reduced to 6 below zero. The petroleum liquid easily depresses the mercury to 19 below zero, freezing the skin with certainty in five or ten seconds. Dr. Bigelow says that the rhigolene is more convenient, and more easily controlled, than the freezing mixtures hitherto employed. Being quick in its action, inexpensive, and comparatively odourless, he thinks it will supersede ether or chloroform for small operations in private houses. It is not adapted for large operations, a first congelation being evanescent and a continued or general congelation, rendering the dangers of frost-bite or mortification imminent.

Electricity in a Cotton Mill.—The *Lowell* (Mass.) *Courier* of March 23rd, says: "It is a general truth that friction developes electricity, and most workmen know that a machine belt at high speed, by its friction with the air, is highly electrified. It has for years been a common experiment for a workman to light gas burners by holding one hand to a fast going belt and the other to the open burner. This matter was curiously demonstrated in the Appleton Mills of this city on Wednesday. A strong smell of fire being noticed, the premises were carefully searched, and a small quantity of cotton lint, inside a belt casing, was found on fire. The lint lay upon a beam which was within 4in. of a belt some 15in. wide, and moving some 220 revolutions a minute. In the beam was an iron bolt, the head of which was towards the belt. From the belt to the bolt was passing a stream of electric sparks, which had set the cotton lint on fire. After attending to the case, Mr. Motley, the agent, opened the casing of a similar belt in another mill. The beam in this case was 14in. from the belt; but the stream of electric sparks was at once seen jumping across the beam, although it had not set fire to anything. Perhaps some of the cases of fire from supposed 'spontaneous combustion' are due to electricity from machinery. The subject is an interesting one for investigation, and probably a profitable one."

Iron of America.—The United States Revenue Commission have laid before the Secretary of the Treasury a report in regard to iron and steel, comparing the resources of this country with those of Europe, Asia, and America. We learn that in 1830 the United States became the largest consumers, and continue so to this time. Our national advantages for the production of iron and steel are not surpassed in the world, and we have learnt to avail ourselves of them. We shall soon become the largest producers, although it must be long before it can be to our interest to send iron from our shores. England now employs iron to the extent of 160lbs. per head of population, and exports more than she consumes. We manufacture 1,500,000 tons, and import about 300,000 additional. Our consumption does not exceed 130lb. per head. The Commission report that in the manufacture of steel our country has nearly emancipated itself from dependence upon others. The American cast steel has been tried throughout all the manufacturing States by the most skilful manipulators of fine cutlery, tools, and in both heavy and delicate machinery, and the evidence of its excellent quality is beyond dispute.—*New York Herald.*

Nitro-Glycerine.—It appears in experiments conducted at Nolte's quarry, Eighty-third-street, New York, under the direction of the Swedish engineer, Mr. Nobel, that when "wood naptha which is methylic alcohol, was dissolved in the oil nitro-glycerine, it was shown that neither by heat, nor by percussion, could the mixture be exploded. When the mixture was washed with water, the naphtha was thereby separated, and the oil resumed its ordinary explosive properties."

Petroleum.—It is confidently asserted that "indications" occur on the surface of various parts of Shropshire which lead to an inference that oil, petroleum, and pitchy fluids are to be found in that part of England. Coalbrookdale, Coalport, Tarback Dingle, Caughley, Benthall, Broseley, and adjacent places, have been named with confidence. We hear of borings being arranged for, to settle the question. The oil-pit which has been sunk at Leeswood-green, in Flintshire, continues in active operation, and is increasing in product. Vigorous explorations are being carried on in the Buckley and Haywar-

den districts, to which a new value has recently sprung up to the manifest advantage of all around.

PRESERVING IRON.—A Parisian physician, Dr. de Brion, has announced his discovery, which he has patented, for treating india-rubber, so that when used on iron it assumes the appearance of an enamel-paint. It professes to be absolutely proof against the action of the atmosphere, as well as the power of all liquids, including the most potent acids, to affect iron. The preparation is applied cold, and in a liquid state, similar in consistency, &c., to common paint generally used for iron work. The coating, when necessary, may be so thin as scarcely to be detected, leaving the protected surfaces sharply defined. It quickly hardens.

INDIGO.—Much indigo has been lost to dyers and others in various ways. M. Leuchs of Nuremburg, avails himself of the property possessed by pectine of changing insoluble blue into soluble white indigo. Pectine is found plentiful in pumpkins, melons, &c., but most abundantly in turnips. It is only necessary to cut them into small pieces, say five parts, one of indigo and one hundred by weight, of caustic ley raised to 75° C. The indigo in a short time becomes colourless and soluble. The turnips may be put into a wire cage at the onset, and suspended in the liquor. The temperature should now be raised to the boiling point, and when the indigo is colourless the solution is decanted off, and requires no further preparation for use. The blue colour returns to cloths dyed in this solution after a short exposure to the light.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—The next annual meeting will be held at Nottingham, on Wednesday, August 22nd; and the following days, under the presidency of W. R. Grove, Esq., Q.C., F.R.S., the eminent barrister, the contriver of the electric battery distinguished by his name. He is also the author of the "Correlation of Physical Forces," and of many papers expounding other important discoveries in natural philosophy. Information concerning the local arrangements for the forthcoming meeting may be obtained from the local secretaries at Nottingham, Dr. Robertson, E. J. Lowe, Esq., F.R.A.S., Rev. J. F. M'Callam, and the notices of papers proposed to be read should be sent to the assistant general secretary before August 1st.

IT IS STATED, on good authority, that the cutlery establishments of Sheffield alone consume annually the ivory which is supplied by slaying more than 20,000 elephants.

THE ABBE RICHARD has represented to the French Academy of Sciences, that in digging a well he has discovered an ancient flint workshop, containing the usual hammers, anvils, arrow-heads, &c., to the extent of several boxes' full.

MR. MILNER GIBSON is conducting a bill through Parliament for the amendment of the law with respect to the carriage and deposit of dangerous goods. This, of course refers to nitro-glycerine, gunpowder, lucifer-matches, and the like combustibles. We have not seen the bill, and therefore refrain from referring to it more fully at present.

COLLIERIES.—The subject of our coal supply is soon to be submitted in detail to a Governmental commission, for its opinion of those facts which will be duly brought under its notice. The members of this commission will, no doubt, be selected for some especial qualification, so that the whole question may be fairly ventilated. It would tend to the satisfaction of the colliers and many others, if the economy of these underground workings were also as fairly examined by the same commission, with a view to the better avoidance of such sacrifices of the men's lives as, almost weekly are thrust on our attention, and commiseration for the widows and orphans on our sympathy.

THE GOLD MEDAL of the Society of Arts has this year been awarded to the venerable and indefatigable Professor Faraday, "for his discoveries in electricity, magnetism, and chemistry, which in their application to the industries of the world, have so largely promoted arts, manufactures, and commerce."

IN THE UNITED STATES, on the 17th March, Mr. Connes introduced the following resolution:—Resolved, that the Secretary of the Navy furnish, through a report of the Naval Observatory, the summit levels and distances, by surveys, of the various proposed lines for inter-oceanic canals and railroads between the waters of the Atlantic and Pacific Oceans; and also their relative merits as practicable lines for the construction of a ship canal, and especially as relates to the Honduras, Tahuantepec, Nicaragua, Panama, and Atrato lines; and also whether in the opinion of the superintendent, the Isthmus of Darien has been satisfactorily explored, and if so, furnish in detail, charts, plans, lines of levels, and all information connected therewith, and upon what authorities they are based.—Adopted.

NAVAL ENGINEERING.

MESSRS. THOMSON launched from their building-yard at Govan, the screw-steamer *Snipe*, of 820 tons and 160 horse-power, for the Messrs. Burns.

MESSRS. CAIRD & Co. launched a large screw-steamer named the *Deutschland*, of 2,500 tons, for the North German Lloyd's Company.

THE NEW STEAMER "ELWY" is intended for the Rhyl station. The *Elwy* started for Rhyl, which place she reached in 1 hour and 39 minutes, a distance of 30 miles, and came from there in 1 hour and 39 minutes. Her length is 210ft., breadth, 20ft., depth, 11ft. 120 horse-power.

THE SCREW FRIGATE "LIVERPOOL," 35, 600 horses-power, Captain John Seccombe just completed in her refit for further service, has made an official trial of her speed over the measured mile in Stokes Bay. The ship is complete in every respect, and ready to proceed from Spithead to sea at an hour's notice. On weighing her anchor from Spithead to the trial ground, her draught of water was 21ft. 3in. forward, and 23ft. 2in. aft. Coals in bunkers, 360 tons. Six runs were made over the measured mile with full-boiler power, and four runs with half-boiler power. The full-power runs gave the ship a mean speed of 10·050 knots, and those at half power 8·204 knots. The wind was light, and water quite smooth.

RAPID OCEAN STEAMING.—The Hamburg and American Company's steamship, *Allemannia* which recently arrived at Cowes, made the fastest run yet accomplished from New York to this port by a screw steamer. The *Allemnnia* passed Sandy Hook at 2.30 p.m. on the 5th inst., and the following abstract of her log will show the speed maintained during every subsequent 24 hours up to 12 o'clock at noon each day.—

May 6—	40.52 ...	67.44 ...	287 knots ...	N.N.W., light.
„ 7—	42.16 ...	61.18 ...	315 „ ...	calm.
„ 8—	43.29 ...	54.41 ...	304 „ ...	N.E., fresh and foggy.
„ 9—	44.17 ...	47.45 ...	300 „ ...	N. fresh and rough sea.
„ 10—	45.50 ...	40.29 ...	326 „ ...	N.N.W. to N.E.
„ 11—	47.33 ...	33.25 ...	306 „ ...	E. to S.E. light.
„ 12—	49.23 ...	25.45 ...	322 „ ...	S.S.E. to S., strong.
„ 13—	50.00 ...	17.18 ...	329 „ ...	S., moderate.
„ 14—	49.35 ...	8.23 ...	235 „ ...	S.W., fresh.
„ 15—	Passed the Needles at 11.30 a.m. 280 E., strong.			

The voyage was made in 9 days 21 hours, and deducting 5 hours for difference of longitude the actual steaming time of the voyage was 9 days 16 hours. Distance, 3,104 knots; the average being 13.3 knots per hour. The *Allemannia* was built at the Northam ironworks, and was launched about this time last year.

RECOVERY OF THE STEAMER "HARVEST QUEEN."—The *Harvest Queen* steamship, belonging to West Hartlepool, which sank in the Tay on the Newcome Sand, after being in collision with the steamship *London*, of Dundee, has been brought to Dundee Docks. The place where she sank was composed of shifting sands, so that in a few days she parted right amidships. The breach by great exertion was temporarily repaired, and the vessel was taken a short distance further up the river, and placed on a solid and equal beach. There the damage done to her was sufficiently repaired to allow of her being towed up to Dundee. The steamer, as she lay on the Newcome Sand, was bought at public auction for £500; and it is expected that the parties who purchased her will make a handsome profit by the transaction, as, although a considerable sum was spent in repairing and raising her, she is a large iron vessel, recently built, and worth from £5,000 to £6,000.—*Scotsman.*

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—At a recent meeting of this institution it was resolved that a petition should be presented to Parliament in favour of the amendment act for the admeasurement of the registration tonnage of ships. The petition has since been presented.

LAUNCHES.

LAUNCH OF AN IRON FLOATING DOCK AT CALLAO.—The following is from the *Commercio* of Lima, of the 24th April:—"To-day, at 2.38 p.m., the great iron floating dock constructed in this port under the direction of the manager of the Pacific Steam Navigation Company, George Petrie, Esq., was launched. The operation to which we refer was effected with a success which rarely attends such great works even in places where they have every resource to secure success. On the signal being given by the firing of a cannon, the ropes which held the buoys were cut, and a few strokes of the hydraulic rams placed underneath being given, the dock began to glide down the ways, at first slowly, and gradually increasing in velocity, till at last, amidst the great cheering of the assembled multitude, the dock reached the water. The powerful iron floating dock, established in Callao, without a rival in South America, remains afloat out of all danger, and bears the name of St. George."

A SCREW STEAMER, the *Lasborough*, was launched from the yard of Messrs. Iliff, Mounsey, and Co., at the South Dock, Sunderland, on the 13th ult. The vessel, built for Mr. R. H. Gaynes, and intended for St. Petersburg trade, is of 900 tons register, 210ft. in length over all, depth 20ft. 6in., with 30ft. beam. She is built on a somewhat novel principle, the bottom being formed by four longitudinal keelsons extending right fore and aft, stiffened by transverse floors on every other frame, forming four box girders on each side of the centre keelson, which latter is of great strength and rigidity. This arrangement is said to combine strength of bottom with large capacity for water ballast. Her engines are from Hawthorn's establishment at Newcastle, in addition to which she is fitted with three steam winches, and has Brown and Harfield's patent windlass.

AT DUNDEE, on the 14th ult., from the yard of Messrs. Stephen and Sons, a clipper composite-built ship. She is 211ft. long, 35ft. broad, 22ft. deep, 1,179 tons N.N.M., or 1,241 tons builders' measurement. She was named the *Corona*. The *Corona* is classed 15 years A 1 at Lloyd's, and is fitted to convey passengers or troops in her 'tween decks. She is the property of the builders.

ON THE 31st., Messrs. Charles Connell and Co., launched from their west shipbuilding-yard at Overnewtown, an iron sailing ship, named the *Glenbervie*, of 800 tons register, classed AA at Lloyd's

THERE WAS also launched on the same day, from the building yard of Messrs. Kirkpatrick, M'Intyre, and Co., Port Glasgow, a small screw steamer named the *Chieftain's Bride*. Length, 88ft.; breadth of beam, 18ft.; and depth of hold, 9ft. 6in.; tonnage, 135 B.M. She will be supplied by Messrs. Blackwood and Gordon with a pair of direct acting engines, inverted cylinders of 14in. diameter. This vessel is intended for the Highland trade.

TELEGRAPHIC ENGINEERING.

A TRIAL of skill recently took place between telegraphic operators of New York and of the New England States. The prize, a gold telegraph key, was awarded to a Mr. Kettles, of Fall River, Massachusetts, who telegraphed 250 words in six minutes and fifteen seconds.

RAILWAYS.

THE PANAMA RAILROAD ACROSS THE ISTHMUS.—By our files of South America papers now to hand, we perceive much complaining of merchants that "their goods are often lying in Aspinwall for fifteen or twenty days after their arrival before they can be sent across on the road to Panama. The agents of the steamers are grumbling that they cannot get their freight in reasonable time, in fact general dissatisfaction exists from one end to the other. We presume a mistaken economy, ruinous alike to the road, and its supporters, is the cause, but some change must be made for the better. Merchants cannot afford to have their goods detained for weeks, in the hot moist climate of Aspinwall, when they are losing the sale of them here three or four times over. The excuse of high wages, or scarcity of cars, has no logic for them who pay the freight on demand. Every one is crying out for a more liberal policy in the present management, and every circumstance connected with the trade demand it."

FIVE OF THE ELLIPTICAL ARCHES of the North Union Railway, which runs from Preston southward, and which arches are of 120ft. span each, have been let to Messrs. Mullin and McMahon, at the enormous sum of £80,000.

RAILWAY CONTACTORS' PRECAUTION.—We understand that the principal railway contractors in the west of Scotland, seeing that short-time strikes, lock-outs, and high wages are the order of the day, have arranged with their various employers for an extension of time for the completion of their contracts, in event of unreasonable demand or strikes on the part of their labourers or workmen.

MINES, METALLURGY, &c.

THE MINES in the vicinity of San Luis Potosi, especially the celebrated Real Catoree mines are all being assiduously worked and prospering. During the last eight months 1,500,000 dollars of silver was coined there. The Real del Monti mines near the capital are doing well. The new imperial coinage has on one side the Mexican coat of arms, the eagle, the serpent, and the cactus. On the other side is the handsome face of Maximillian.

BOILER EXPLOSIONS.

BOILER EXPLOSION IN JAMAICA.—On the 15th March last, the steam boiler at Barrett Hall sugar estate, near Falmouth, Jamaica, exploded with fearful violence occasioning a loss of nine lives. The boiler was a plain cylindrical one, 15ft. long, and 5ft. diameter, of ⅜ plates, with a single internal flue about 25in. in diameter of ¼in. plates. The flue collapsed from end to end, and gave way at the chimney end. The boiler was thrown high in the air, and carried to a distance of about 140yds., striking the ground and rebounding two or three times; ultimately the outer shell gave way at the last transverse seam of rivets near the chimney. It appears that the flue had previously collapsed in 1862, and had been repaired with ⅜in. plates, and that on the present occasion the rent commenced at the junction of the new work with the old. The boiler was ordinarily worked at about 50lbs. pressure, though occasionally loaded up to over 80lbs. This is another item in the long list of accidents arising simply from the weakness of the inner flue, and which might, in all human probability, have been averted by a proper construction of the flue, or by strengthening it with rings of angle or tire iron, or water tubes.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated May 17th, 1866.

1405 D. J. Fleetwood—Machinery for raising and stamping metal
1406 P. Vandirbyl—Condensing apparatus

Dated May 18th, 1866.

1407 R. Gesell and A. Lea—Preparing and fluting picture and other frames and mouldings
1408 W. A. Lyttle—Steam generators
1409 P. J. Morand—Infants' feeding bottles
1410 J. Bernard—Generating and heating steam, gas, and vapours
1411—J. Sharp and R. Smith—Combustible and inextinguishable compound
1412 J. W. Fox—Apparatus for containing and dispersing liquid scents and other fluids
1413 P. Devilliard and A. Postweiler—Doors to Landan and other carriages similar thereto
1414 W. Bunger—Machines for cutting and harvesting grain and grass crops
1415 R. Griffiths and A. Rigg — Propelling and steering steam vessels
1416 J. Purcell—Breaking and crushing ice

Dated May 19th, 1866.

1417 G. B. Fosberry — Improvements in the lock and other parts of breech-loading firearms and in cartridges for the same
1418 J Brown—Cutting and slicing timber
1419 H. Wilson—Cocks and taps for the attachment of pipes
1420 J L Field and J. K. Field—Adaptable ends for candles
1421 G. J. Vincent—Securing or holding flat bottomed or bridge rails
1422 M. Semple—Obtaining motive power
1423 N. Walton—Apparatus fur soaping, washing, fulling, milling, wringing, mangling, and ironing clothes and fabrics
1424 J B. Brown—Mowing machines
1425 J. C. Ramsden — Manufacture of reeds for weaving and other purposes.

Dated May 21st, 1866.

1426 H. B. Barlow—Preparing and spinning hemp and other fibrous substances
1427 J. Tombs—Manufacture of metallic bedsteads
1428 A. Casse—Manufacture of textile fabrics
1429 W. Gadd and J. Moore—Looms for weaving
1430 J. Livesey—Treating cast iron
1431 J. M. Dunlop—Machinery for cutting india rubber
1432 A. B. Blackburn—Preparing lubricating compounds
1433 A. Crichton—Marine steam engines and surface condensers
1434 J. T. Wood—Compressing and packing cotton
1435 P. J. Messent—Apparatus for mixing concrete and other materials

Dated May 22nd, 1866.

1436 J. McLintock and J. Jagger — Heddles or healds for weaving
1437 C. P. Coles—Construction of vessels of war, forts, and other defences
1438 G. W. Homer — Breaking, pulverising, or scarifying land
1439 J. Hinks and J. Hinks—Lamps for burning petroleum
1440 W. E. Newton — Machinery employed in dyeing yarns
1441 A. V. Newton—Rotary steam engines
1442 J. J. Marcais—Treatment of slags, ores, and compounds of tin

Dated May 23rd, 1866.

1443 I. James—Improved clod crusher
1444 W. Rowan—Machinery for preparing and cleaning flax
1445 E. Gripper—Treatment of grains from brewers
1446 J. Lewenberg—Composition for beautifying the complexion
1447 P. M. Balin—Manufacture of paper hangings
1448 G. Haseltine—Moulds or matrices of stereotype plates
1449 G. Haseltine—Metal hoops for casks
1450 J. Longbottom—Method of applying heat in the drying and calendering of yarns
1451 S. Douglas—Motive power engines
1452 T. Greenwood—Dressing silk

Dated May 24th, 1866.

1453 W. Snell—Tobacco pipes
1454 W. Heathfield—Construction of iron girders and joists
1455 J. Cunningham and R. Cunningham—Weaving ornamental fabrics
1456 A. Westhead —Apparatus employed in laying electric telegraph cables
1457 T. Green Improvements in steam and other boilers

Dated May 25th, 1866.

1458 J. Cooke—Rails or permanent way of railway
1559 J. W. Evans—Machinery for the manufacture of coiled springs
1460 J. Emme — Cartridge extractor for breech-loading guns
1461 W. H. C. Voss — Improvements in rotary, steam, and hydraulic engines
1462 W. Gibson and E. Ellis—Apparatus for the manufacture of metal rods
1463 T. Blain—Spinning frames
1464 J. Purdey—Breech loading firearms
1465 J. W. Hoffmann—Hanging centre stops for doors
1466 J. T. King—Machine for the manufacture of augers
1467 E. Bevan and A. Fleming —Warming and keeping warm articles of food
1468 E. Buchner—Manufacture of gas
1469 G. F. Goransson — Improvements in blast furnaces

Dated May 26th, 1866.

1470 B. F. Weatherdon—Gas pyrometers
1471 J. D. Whelpley and J. J. Storer—Use and application of fuel
1472 H. A. Bonneville—Ovens for baking bread and other aliments
1473 C. McFarlane—Album for exhibiting photographs and other pictures
1474 J. G Rollins—Horse rakes
1475 D. Thomson and W. Porter—Machinery used in raising and forcing water and other fluids

Dated May 28th, 1866.

1476 G. Green—Construction of sounding boards and the governing apparatus of the bellows for organs harmoniums, and other similar wind instruments
1477 C. T. Hill—Manufacture of rolls for rolling metals
1478 T. Boyle— Utilising the explosive force of discharges in guns
1479 R. Canham—Apparatus employed when making moulds for casting metals
1480 C Lock—A moveable heel and sole of a boot
1481 G. Spencer—Supporting the rails of railways
1482 H. Stuttle—Hydraulic presses for the manufacture of sheet lead pipes
1483 W. Clark—Scoops and elevators for excavating
1484 J. Erskine—Apparatus for turning over or closing the ends of cartridges
1485 J. H. Johnson—Composition for journal boxes or bearings
1486 C. F. Henwood—Ships' rudders
1487 G. Davies—Apparatus fur supplying steam boilers with water
1488 D. Duff—Improvements in gas regulators

Dated May 29th, 1866.

1489 T. Woodward and G. Fellows — Extracting cartridges and cartridge cases from firearms
1490 R. Maynard and R. Maynard—Horse rakes
1491 J. Hall—A perforated elastic faced cellular target
1492 J. D. Whelpley and J. J. Storer—Process for removing dust and gases from air
1493 J. D. Whelpley and J. J. Storer—Obtaining metals and salable products from ores and minerals
1494 G. Haseltine — Means for regulating and registering the tension of pianoforte strings
1495 G. Haseltine— Composition for removing incrustation
1496 I. Delcambre—Machinery for setting or composing and distributing printing types
1497 R. B. Bowman—Propelling vessels by the reaction of water
1498 F. Hewitt—Rudders and stern posts
1499 T. Haigh—Coolers fur the use of brewers and others
1500 C. Nurse—Improved fastening applicable as a substitute for buckles
1501 W. R. Pape—Construction of breech-loading and other rifles and guns
1502 J. Wadsworth—Method of rendering the soles of boots more durable
1503 W. E. Newton—Connecting metallic wires
1504 C. T. Bowdum - Telegraphic printing apparatus
1505 W. Bayliss — Construction of continuous wrought iron fencing hurdles and gates

Dated May 30th, 1866.

1506 H. Schofield—Weft forks
1507 G. T. Bousfield—Machinery for cutting files
1508 E. A. Pontifex—Improvements in refrigerators
1509 G. P. Evelyn—Propelling boats and vessels
1510 W. R. Hammersley—Fluid compasses
1511 James, Earl of Caithness — Cleaning boiler tubes

Dated May 31st, 1866.

1512 J. Punshon—Signal bell for registering on a dial plate all signals given by a hammer
1513 W. Clark—Apparatus for recording the distance travelled by vehicles and the time occupied therein
1514 H. W. Hire and J. White—Construction of parts of ships and other vessels
1515 E. T Bellhouse and W. J. Dorning—Manufacture of keys
1516 E. T. Bellhouse and W J. Dorning—Hydraulic pumps and valves connected therewith
1517 A. R Cunningham—Shaving brushes
1518 G. T. Bousfield —Tanning hides and skins
1519 J East—Sawing machinery
1520 T. J. Smith—Apparatus to be employed in drawing liquids from casks
1521 J. H Johnson—Transmission of electric telegraphic despatches
1522 J. H. Johnson—Deodorising of crude rock or mineral oil
1523 J. Linnett—Manufacture of paper and cardboard boxes
1524 G. R. Mather—Apparatus for holding or setting work to be cut
1525 H. K Newton—Construction of water cocks or hydrants
1526 W. E. Newton—Improvements in railways
1527 G. T. Bousfield—Preparing fibrous materials for spinning and weaving

Dated June 1st, 1866.

1528 J. Clyne—Improved portable mangle
1529 C. Brautigam—Wheeled carriages
1530 J. Yule—Steam engines
1531 M. A. Caire—Improvements in triggers for small arms
1532 A. V. Newton—Machinery fur burring and cleansing wool and other fibrous substances
1533 H. Crawfurd and J. Crawfurd—Improvements in finishing thread
1534 W. Burrows and J. Burrows — Locomotive engines for common roads

Dated June 2nd, 1866.

1535 S. Turton—Improvements applicable to steam boilers or generators
1536 C T. Julios—Construction of anchors
1537 A. Paraf—Improvements in dyeing
1538 T. Neville and W Gorton—Improved means of propelling vessels
1539 A. B. Brown—Engines for pumping water
1540 J. Knight—Self-acting railway signals
1541 E. P. H. Vaughan—Construction of reflectors
1542 A. A. Bois—Machinery for drawing and twisting cotton
1543 J. Lecoq—Machinery for combing hemp

Dated June 4th, 1866.

1544 C. Henderson—Girders manufactured in iron
1545 J. B. Fenby—Locks and latches
1546 M C. Rogers—Apparatus for manufacturing artificial teeth
1547 J. Sainty—Construction of horse shoes
1548 A. Moucrieff—Mounting and working of ordnance
1549 C. McFarland—Machinery for cutting corks and bungs

Dated June 5th, 1866.

1550 N. Brand—Making hoes, trowels, and other similar instruments
1551 E. Farmar—Apparatus to be used in training or growing hops
1552 D. A. Dumuis, E. J. F. Flicoteaux, E. W. Niblett, and M. L. J. Lavater—Improvements in water closets
1553 J. M. Tankard and J. Cockcroft—Machinery for spinning worsted
1554 J. H. Johnson—Making envelopes and paper bags
1555 C. A. McEvoy—Improvements in shells
1556 W. E. Newton—Machinery for gumming and printing envelopes
1557 T. W. Wedlake—Construction of irrigators

Dated June 6th, 1866.

1558 J. Hopwood—Looms for weaving
1559 W. Lawrence—Manufacture of malt
1560 W. Lawrence—Apparatus for the treatment of worts
1561 L. Morris—Improvements in muffs
1562 J. Loader—Raising and lowering weights
1563 P. Righetti—Apparatus for generating heat
1564 A. Parkes—Manufacture of compounds in the nature of kamptulicon
1565 A. Young and W. Young—Construction of streets
1566 H. Bateman—Pumps and fire engines
1567 H. Greaves—Construction of parts of railways

Dated June 7th, 1866.

1568 J. C. Sellars—Improvements in treating coal
1569 J. G. Tongue—Electro-magnetic striking attachments for paper ruling machines
1570 A. Grivel—Construction of safes
1571 F. H. Wenham—Apparatus for aerial navigation
1572 J. J. Friedmann — Preparation of materials applicable to the manufacture of bats
1573 W. E Newton—Jars for preserving fruits
1574 W. E. Newton—Drilling machines

Dated June 8th, 1866.

1575 C. D. Abel—Improvements in travelling bags
1576 W. J. Fraser—Improvements in steam boilers
1577 J. Armstrong—Manufacture of crussings for permanent way of railways
1578 W. E. Newton—Composition for journal boxes or bearings
1579 D T. Lee—Improvements in lay figures
1580 J. Cranstoun— Horticultural erections
1581 C. H. Murray—Machinery for making bricks
1582 H. J. Griswold—Manufacture of cards

Dated June 9th, 1866.

1583 J. Moss—Improvements in carding engines
1584 J. J. Ingram and G R. Phillips—Valves for regulating feed suction and other purposes
1585 J. Erskine—Breech-loading guns

Dated June 11th, 1866.

1586 H. A. Dufrené—Decorticating rice and other grains
1587 J. Baxter and J. Hunt—Safes for valuable property
1588 D. Cochrane—Spinning frames
1589 A. Thornton—Heating the feed water of steam boilers
1590 P. Lerouge—New mode of advertising
1591 J. Seward—Apparatus for preventing priming, and for the discharge of condensed steam from steam pipes
1592 A. Parks—Manufacture of brushes

Dated June 12th, 1866.

1593 S. Lees—Furnaces for consuming petroleum and other hydrocarbons
1594 T. J. Leigh—Improvements in the method of burning coals
1595 G. Allix—Reefing and furling fore and aft sails
1596 P. H. Limet—Means for providing furrows in the surface of metals
1597 F. W. Kurz—Construction of locks
1598 F. W Kurz—Construction of safes
1599 R. A Wright—Improvements in furnaces
1600 J. Nicholas—Improvements in retorts

Dated June 13th, 1866.

1601 G. D. Kittor—Steam engines
1602 J. Holloway—Buckles or fastenings for braces
1603 S Bayliss—Breech-loading firearms
1604 F. Cambridge—Waggons or carts for carrying hay
1605 R. Lancaster—Lock or fastener for securing the lids of milk cans
1606 E H. Waldenstrom and T. Wrigley—Carding engines
1607 J. A. Forrest—Construction of lanterns
1608 J. Hunt—Heating bakers' ovens
1609 S. Kilby and G. Dixon—Thrashing machines
1610 W. H. Hall and J. Cooke— Miners' safety lamps
1611 A. P. Price—Method of effecting the combustion of fuel
1612 J. C. Cole—Improvements in coffins

Dated June 14th, 1866.

1613 J. J. Harrison and E. Harrison—Looms for weaving
1614 E. Morris—Apparatus employed in churning
1615 G. D. Malam—Purifying of ammoniacal liquor by an improved process
1616 J. Carter — Opening, closing, and securing windows, doors, &c
1617 J. Stenson—Manufacture and remelting of iron or steel
1618 W. Bellhouse—Improvement in hoists
1619 J. B Payne—Manufacture of fishing and other nets
1620 R. E. Hodges—Improvements in rulers
1621 J. Whitaker—Reaping and mowing machines
1622 W. E. Newton—Construction of breech-loading firearms
1623 W. Knaggs—Manufacture of sugar
1624 A. H. Linningtou—Improvements in anchors
1625 V. Gallet—Manufacture of cast steel

Dated June 15th, 1866.

1626 L. A. de Milly—A new process in the treatment of concrete fatty acids for the manufacture of candles called "Stearine candles"
1627 W. R. Hammersley—Fluid compasses
1628 B. F. Stevens — Treating permanent inflammable gases
1629 J. G. Marshall—Treatment of fibrous materials preparatory to their being spun

Dated June 16th, 1866.

1630 W. Robertson and J. G. Orchar—Looms for weaving
1631 A. Lees and J. B Slater — Machinery for making moulds for casting iron and other metals
1632 G. R. Wilson—Vermin trap
1633 W. B. Brown—Anti acid oil
1634 W. M. Ward—Machinery for the manufacture of fishing and other nets
1635 A. Macdonald—Improvements in locks
1636 G. H. M. Muntz—Certain fittings for gas, steam, and water tubes
1637 G. L. Léclanché—Voltaic piles
1638 G. H. Hopps — Improvements applicable to locks

Dated June 18th, 1866.

1639 J. E. T. Woods—Improvements in the manufacture of pigments
1640 W. B. Patrick—Treatment of animal charcoal used by sugar refiners or others
1641 J. H. Dallmeyer—Compound lenses suitable for photographic uses

Dated June 19th, 1866.

1642 A. Paraf—Fixing colouring matters on textile fabrics
1643 T. Chaloner and J. Billington—Construction of tools for graining
1644 F. B. Lucas—Manufacture of screw nuts and bolts
1645 A. D Renshaw—Shearing of sheep and other animals
1646 F. J. Bolton—Mode of transmitting messages by the electric or magnetic telegraph
1647 T. Blatch— Improvements in rotary and reciprocating engines
1648 E. H. Bentall—Rolling bars for manufacturing nuts
1649 G. T. Bousfield—Process of utilising waste vulcanised india rubber

Dated June 20th, 1866.

1650 E. Pearson—Certain improvements in wearing apparel
1651 A. Miroude—Application of electric light for giving evidence of buoys of every description
1652 J. Nadal—Improved bottle fountain fur pocket and other purposes
1653 A. Bowen—Sewing machines
1654 D. A. Fyfe—Improvements in the manufacture of pulp
1655 E. Bourdier—A hygienical salt box
1656 J. G. Tongue—Machinery for the manufacture of metal cartridges
1657 J. Möller—Obtaining and preparing colouring matter for printing
1658 — Abbot—Better combustion of fuel in steam boilers and other furnaces

Dated June 21st, 1866.

1659 W. Forgie and — Thornton—Construction of lifeboats and sails for the same
1660 L. Hart—Construction of life rafts
1661 B. Browne—Construction of camp or folding bedsteads

THE MYSTERIES OF NUMBERS

BY THE

RT HON. SIR FREDRICK POLLOCK. F.R.S.

Diagram No 1.

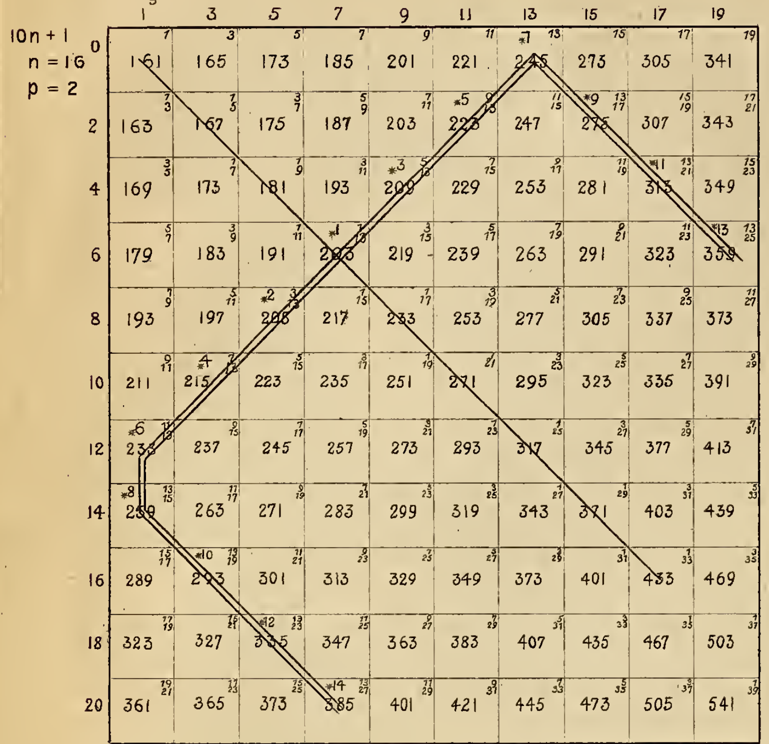


Diagram No 2.

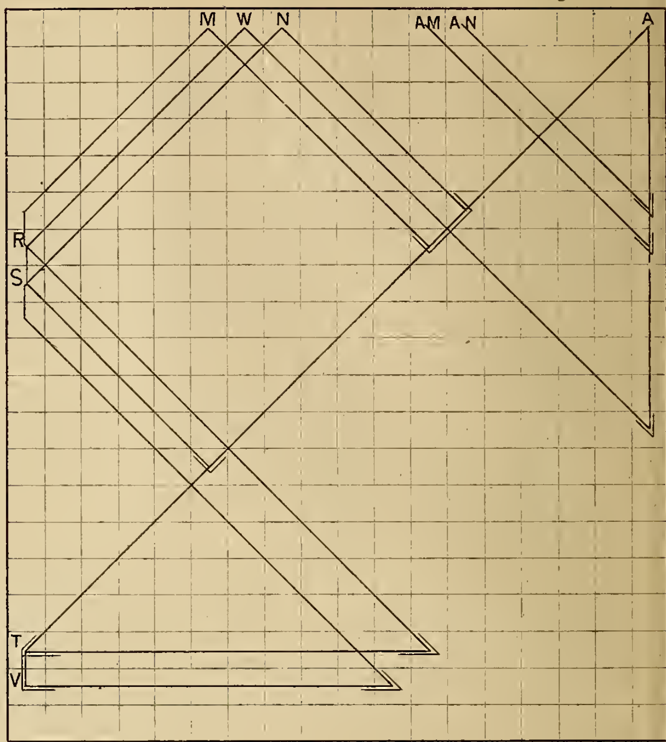


Diagram No 3.

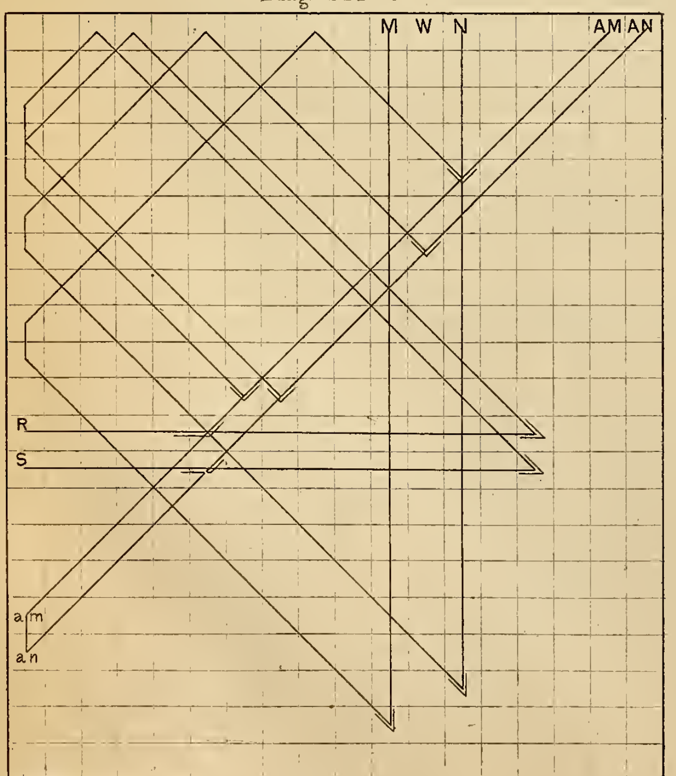
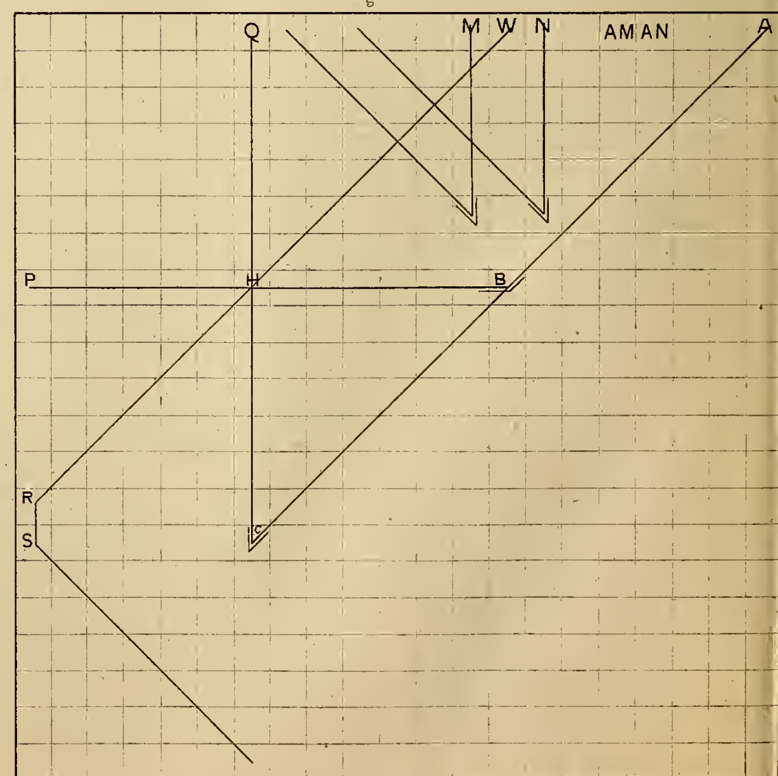


Diagram No 4.



W. Smith. C.E. direx.

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ON THE MYSTERIES OF NUMBERS ALLUDED TO BY FERMAT.

By the Rt. Hon. Sir Frederick Pollock, F.R.S., late Lord Chief Baron, &c.

(*Illustrated by Plate No.* 302.)

The object of this paper is to call attention to certain properties of odd numbers when placed in a square, according to an arrangement to be explained below.

It appears to me probable that these properties are connected with (if, indeed, they be not actually some form of) the mysterious properties of numbers, to which Fermat alludes in the announcement of his theorem (as furnishing the proof of it); for in point of fact these properties give *a method* by which every odd number can be divided into four square numbers, and every number (odd or even) can be divided into not exceeding three triangular numbers.

I am not prepared to say whether or not the method affords a *demonstration*, and proves that it can always be done; but it always does it, and the cause of its success may be distinctly shown. The properties I allude to are scarcely less interesting and curious than the theorem itself, and present results for which I can find no name more appropriate than the *geometry of numbers* for relations appear to be established between various numbers in the square, which relations are not founded on any arithmetical connection between them, but on the positions they respectively occupy in the square of which they form a part.

The arrangement of the numbers is as shown in diagram No. 1, Plate 302. Any odd number (which may be the subject of inquiry) is made the first term of a series, increasing from left to right by the numbers 4, 8, 12, 16, . . . ($4n$). This series forms the horizontal line at the top; each term of the series so formed is made the first term of a series, increasing downwards by the numbers 2, 6, 10, 14, ... ($4n-2$). A square of indefinite magnitude is thus formed, consisting of two sets of series, one set all horizontal, the other set all vertical. 161 is the first number in diagram No. 1.

The result of the arrangement of the two series in the manner above mentioned is the formation of a third set of series, which may be found in the diagonal lines of the square.

If from the first number in the square 161 a diagonal line be drawn towards the opposite corner, it will pass through the first terms of one portion of the third set of series; the second, third, and following terms are taken alternately from each side of the diagonal line. These series increase by 2, 4, 6, 8, &c. . . . ($2n$), and with the exception of one term they are all in the diagonal lines (see diagram No. 1), in which the single thick line passes through the first terms, and the double thick line shows where the terms of the series (the second, third, &c.) belonging to *that* (as a first term) are to be found; the corresponding numbers indicate their order.

1 2 3 4 5 6 7 8
The Nos. 203, 205, 209, 215, 223, 233, 245, 259, &c., compose the series; the terms increase by 2, 4, 6, 8, 10, &c. . . . $2n$. Any number in the diagonal from 161 may be the first term of a similar series.

The diagonal from 163 will give all the other first terms of the third set of series.

In order to explain the indices which appear in the diagram No. 1, and to show in what manner the series are connected with, and pass into each other, it is necessary to point out the properties of the two series which compose the square, and of the third series, which is a necessary result.

All of them have this property in common, that if you can discover the roots of the squares which compose any term of the series with reference to the nature of the series, and the order in the series of that term, then you know the roots of every term in the series, both before and after that term. The first series increases by 4, 8, 12, &c. The indices of the terms of a series so increasing I have made 1, 3, 5, 7, &c., and they are put at the top as being common to all the series that are horizontal.

For this reason, if two numbers differ by 1, as n, $n+1$, and the larger be increased by 1, and the smaller be diminished by 1, and the process be continued, the result will be

$$\begin{array}{ll} n, & n+1, \\ n-1, & n+2, \\ n-2, & n+3, \\ n-3, & n+4, \\ \cdot & \cdot \\ \&c. & \&c. \\ n-(p-1) & n+p. \end{array}$$

If these be treated as roots, the sums of the squares will be

$$\begin{array}{c} 2n^2+2n+1, \\ 2n^2+2n+5, \\ 2n^2+2n+13, \\ 2n^2+2n+25, \\ \&c.\ \&c. \\ 2n^2+2n+2p^2-2p+1. \end{array}$$

The sums of the squares increase by 4, 8, 12, &c.

If therefore the roots of the square, into which any odd number may be divided, be p, q, n, $n+1$, and the number be increased by 4, 8, 12, &c. . . . ($4n$), the mth term in he series will be composed of squares whose roots will be p, q, $n-(m-1)$, $n+m$; two of the roots will be constant, the others will vary, and their differences in the successive terms will be 1, 3, 5, 7, &c. . . . . ($2n-1$) and if you discover the roots of any term in the series, you can find the roots of all the terms.

The second series resembles the first in having two roots constant, and two variable; the differences between the variable roots are, in the first term 0, in the second term 2, in the third term 4, &c., and the indices of the terms are therefore 0, 2, 4, 6, 8, 10, &c., which are placed vertically by the side of the square. For if two numbers are equal, as n, n, and one of them be increased by 1, and the other diminished by 1, and the process be continued, the result will be

$$\left.\begin{array}{ll} n & n \\ n-1, & n+1 \\ n-2, & n+2 \\ n-3, & n+3 \\ \&c. & \&c. \end{array}\right\} \begin{array}{l} \text{If these be treated as} \\ \text{roots, the sums of} \\ \text{their sqaares will be} \end{array} \left\{\begin{array}{l} 2n^2 \\ 2n^2+2 \\ 2n^2+8 \\ 2n^2+18 \\ \&c.\ \&c. \end{array}\right.$$

The sums of the squares increase by 2, 6, 10, 14 . . . . ($4n-2$), and the successive differences of the variable roots are 0, 2, 4, 6, &c.; and if the roots of the squares into which any odd number may be divided be p, q, n, n, and the number be increased by 2, 6, 10, &c., the roots of the mth term will be p, q, $n-(m-1)$, $n+(m-1)$, and if the roots of any any one term be known, the roots of all the others may be found.

The small figures in the upper right-hand corner of each division or small square are the indices of the third set of series. In this set all the roots are variable. The character of the first set of series is, that two roots in every term differ by an odd number; the character of the second set of series is, that two roots in every term differ by an even number; but in the third set of series, the algebraic sum of all the roots of the squares into which the successive terms may be divided is successively 1, 3, 5, 7, 9, &c. (an odd number): the sum of the roots of the squares into which an odd number can be divided cannot be an even number.

The following Table will explain in what manner the series is formed from the roots of the squares into which any odd number may be divided, so as to make the algebraic sum equal to 1. I have preferred to use figures instead o algebraic symbols, as being more readily understood and more easily dealt with; but the result is the same whatever figures or symbols may be used. The series begins from the centre.

Let -7, -3, 2, 9, which are the roots of the squares into which the odd number 143 may be divided, be placed in the centre, and let the positive roots be increased downwards and decreased upwards, and the negative roots increased upwards and decreased downwards, the result will be as in the following Table :—

	Order of terms.	Roots.	Algebraic sums of roots.	Sums of squares of roots.	Order of terms.
	12	4 5 7 —13—9—4 3	—23	275	12
	10	4 5 7 —12—8—3 4	—19	233	10
	8	4 5 7 —11—7—2 5	—15	199	8
	6	4 5 7 —10—6—1 6	—11	173	6
	4	4 5 7 — 9—5 0 7	— 7	155	4
	2	4 5 7 — 8—4 1 8	— 3	145	2
Centre	1	4 5 7 — 7—3 2 9	1	143	1
	3	4 5 7 — 6—2 3 10	5	149	3
	5	4 5 7 — 5—1 4 11	9	163	5
	7	4 5 7 — 4 0 5 12	13	185	7
	9	4 5 7 — 3 1 6 13	17	215	9
	11	4 5 7 — 2 2 7 14	21	253	11
	13	4 5 7 — 1—3 8 15 &c. &c.	25 &c.	299	13

It will be observed that the terms of the series 143, 145, 149, 155, &c., increase by 2, 4, 6, 8 . . . ($2n$). In the column of the sums of the roots 1, 5, 9, 13, &c., increase by 4.

1, — 3, — 7, — 11 decrease by 4; the differences of the roots, if arranged in the order of their numerical value, is always the same throughout the series.

Note.—In the remainder of this paper, every odd number that becomes a term in any of the series is expressed by the roots, the sum of whose squares form the number itself;

$$\boxed{2,\ 3,\ 6,\ 8}$$

means that the number occupying that division or small square is $113 = (2^2+3^2+6^2+8^2)$; a figure (or collection of figures) representing merely the arithmetical value, is put into a circle, thus:—

$$\boxed{\begin{array}{c}113\\ 2,\ 3,\ 6,\ 8\end{array}}$$

Having explained the construction of the square and the indices which belong to the series of which it is composed, I propose to point out the properties which discover the roots of the squares into which the odd numbers (which are found in the different parts of the square) may be divided.

If the first odd number in the square be of the form $(4p + 2).n + 1$ (or $2n + 1$, $6n + 1$, $10n + 1$, $14n + 1$, &c.,) n being of any value whatever, the $(n - p)$th term will be $\boxed{-(p + 1), -p, n, n}$; these are the roots (the number itself would be $2n^2 + 2p^2 + 2p + 1$); and as the index of the nth term is $n + (n - 1)$, or $2n - 1$, the index of the $(n - p)$th will be $2n - (2p + 1)$, and the algebraic sum of the roots may be made equal to the index; it is therefore a term in a diagonal series [that the $(n - p)$th term is $2n^2 + 2p^2 + 2p + 1$, will appear by finding in the usual way the $(n - p)$th term of a series whose first term is $(4p + 2).n + 1$, and the terms of which increase by 4, 8, 12, 16, &c. . . . $4n$]; but as two of the roots are equal, n, n, it is the first term of a vertical series descending, thus:

$$\begin{array}{l} p + 1, p, n, n \\ p + 1, p, (n - 1), n + 1 \\ p + 1, p, (n - 2), n + 2 \\ p + 1, p, (n - 3), (n + 3). \end{array}$$

I call this term A* and indicate it by that letter, and from this term the roots of many others may be derived (which are indicated by other letters connected with A in an invariable manner), whose squares will compose the number that belongs to that term. For example, counting $2p + 1$ squares backward from A is a term I have distinguished as W; the roots of the number belonging to it are

$$\boxed{\overline{p + 1}, p, (n - \overline{4p + 2}), n}$$

These roots may, of course be either positive or negative; arranging them thus, $-\overline{p + 1}, -p, n, -\overline{4p + 2}, n$, we have the algebraic sum of their roots equal to $2n - \overline{6p + 3}$, which is the index of the square in which W is found going backwards from A, the index of which is $2n - \overline{2p + 1}$ (as already stated); immediately adjoining W are two squares which I have called M and N respectively.

M is the term next before W, and is composed of the roots

$$\boxed{n - \overline{2p + 2}, n - \overline{2p + 2}, \overline{3p + 2}, \overline{p + 1}}$$

N is the term next after W, and consists of the roots

$$\boxed{\overline{n - 2p}, \overline{n - 2p}, \overline{3p + 1}, p}$$

Each of these will traverse the square diagonally, the algebraic sums of their roots being equal to the index; the roots of W may also be obtained from A by taking its roots down vertically, making n, n successively $\overline{n - 1}, \overline{n + 1}, \overline{n - 2}, \overline{n + 2}$, &c., until the square is reached, in which the index is $2n + 2p + 1$, and $2n + 2p + 1$ being the arithmetical sum of all the roots of A; A here becomes a term in a series which moves diagonally, and on being carried up towards the left will give the roots of W. When the indices of the squares through which this vertical series passes equal $2n \pm 1$, by making $\overline{p + 1}, p$, one positive and the other negative, the term becomes a term in another series which moves diagonally upwards towards the left. This must occur both when the index equals $2n - 1$ and when it equals $2n + 1$; and as the indices increase downwards uniformly by 2, it follows that $2n - 1$ and $2n + 1$ will be the indices of contiguous terms of the vertical series, and therefore two contiguous terms will become terms of series moving diagonally upwards to the left; and as these two series are contiguous to each other, their terms found in the first series (that is, the series in the top line) will also be contiguous.

These two terms I have designated as AM and AN. AM comes from the term where the index equals $2n + 1$, and AN from the term where the index equals $2n - 1$; the roots of AM are

$$\boxed{0, \overline{2p + 1}, n - \overline{2p + 2}, n,}$$

those of AN are

$$\boxed{0, \overline{2p + 1}, n - 2p, n,}$$

and being arranged thus,

$$\boxed{-\overline{2p + 1}, 0, n - \overline{2p + 2}, n,}\ \boxed{-\overline{2p + 1}, 0, n - \overline{2p}, n,}$$

will move diagonally downwards to the left; and as each of these have two roots that differ in one case by $2p$, in the other by $2p + 2$, the terms in these series that are parallel to those terms in the first vertical series which have their external indices respectively $2p$ and $2p + 2$, the terms of AM and AN will (I say) in these places become terms in series moving vertically, and on being followed up to the series in the top row will be found to give the roots of M and N. The roots of M and N may be obtained by another method, as follows:—As the algebraic sum of the roots of A equals its index, therefore A is a term in a

* See Diagrams Nos. 2, 3, and 4.

diagonal series moving downwards towards the left; and as two of its roots, $p, p+1$, differ by 1, it follows that whenever the value of n has been so altered that $2n \pm 1$ equals the index by making $\overline{p+1}, p$, one positive and the other negative, the term becomes a term in another series, which series will move at right angles to the series last mentioned. Now taking the series which moves to the left of A, it is clear that this result will obtain in two places; first, when the altered value of n makes $2n - 1$ equal the index, and secondly, when the altered value of n makes $2n + 1$ equal the index. The first of these going up gives the roots of N, the second gives those of M, and these roots are identical with those obtained from AM and AN.

The index of A is $2n - \overline{2p+1}$, therefore when n in moving downwards $n+1, n+2, n+3, \ldots\ldots$

$2n - \overline{3p+2}$,	$2n - \overline{3p+1}$,

$\overline{p+1}, p$ being two of the roots of each term in this series; by adding $p+1$ to the first-mentioned root and p to the other, these two terms will be found to be terms in two horizontal series, of which the first terms are in the first vertical series, and these terms both of them make the diagonal index, and therefore are terms in a diagonal series which, rising towards the right, give the roots of W.

A descends diagonally to the left, and on each side of the line which leads to W changes to cross diagonals which lead to M and N. W leads diagonally to the left to R and S, and where it crosses AT changes and goes up to A. M goes down into R, and then diagonally to where it meets the horizontal series from T; its roots there correspond with the series from T; it returns to T and up to A. In like manner N goes down through S to the line from V, and so to V and up to A. R and S go each of them across to the vertical line from A, and so up to A: every term through which these lines pass has the four roots indicated whose squares would make the term.

The number of terms in the whole square, whose four roots may be expressed in terms of p and n, is very considerable; and it may be well now to present some skeleton diagrams of the many ways in which certain members of the squares are *invariably* connected.

I propose to exhibit several (to avoid confusion, which would arise from putting all in one diagram); these do not by any means include all the connexions that exist; but whatever may be the value of n or p, a number of the form $(4p+2) \times n + 1$, whether it be $2n+1$, $6n+1$, $10n+1$, &c., and whatever be the value of n, gives the following results. (See diagram No. 2.) At the $n - p$)th term there will be A, which descends vertically till the index is $2n - 1$, then $2n + 1$, and from these rise up in diagonals AN and AM, as already mentioned. A then further descends till the index is equal to $2n + 2p + 1$, when it rises in a diagonal to W.

Diagram No. 3 shows certain connexions between AM and AN and other terms in the square. AM is always $-\overline{2p+1}, 0, n - \overline{(2p+2,)}\, n$, AN is always $-\overline{2p+1}, 0, n - \overline{2p}, n$.

If the series in which AM is a term be carried down diagonally till 0 becomes $2p+1$ (that is $2p+1$ places), it becomes a term in a diagonal series that intersects it and rises to the top, then goes down to the horizontal series from R, where it becomes a term in that series and passes to where it is below M and rises vertically up to it. AN does the same with respect to the series from S, and rises up to N.

If the term AM descends till $n - \overline{2p+2} = 2p+1$, it rises to the left in another diagonal series and goes on till it crosses M, where it is found that the roots are always the same as those which arise from M, descending by means of its two equal roots. The term AN does the same with respect to N.

If AM descend to the margin at *am*, and one step further into *an*, and AN descends to *an*, they will be found to have the same roots, and they will be

from AM
$-\overline{2p+1}, 1, n - \overline{2p+1}, n$
from AN
$-\overline{2p+1}, -1, n - \overline{2p+1}, n$

The only difference being that in the one case 1 is positive, in the other it is negative; but whatever be the value of p or n, in this portion or term of the square 1 is *always* one of the roots.

In crossing the two horizontal series from R and S, it will always be found that at the points of intersection the roots of AM correspond with the roots of the series from R, and the roots from AN correspond with those from S.

Diagram No. 4 exhibits the way in which B, C, P, and Q are connected together. The roots of A at the $(n-p)$th square will always be $-(p+1)$, $-p, n, n$, and $p+1, p$ must be one of them odd, the other even; therefore, whether n be odd or even, an odd number will be formed by $-(p+1), n$, or $-p, n$. The series from A descending diagonally has the roots n, n decreasing, but the negative roots increasing. The differences will continue the same; and when the series arrives under that index which corresponds to the odd number $-(p+1)\, n$, or $-p, n$, it becomes a term in a horizontal series which goes to P, two terms of which are always $p, p+1$. W, in descending diagonally, has its index on reaching PB 1. When A has descended so as to reach the even number of the two, $[-(p+1), n, -p, n,]$ it rises in a vertical series to Q; and the three series, WR, BP, CQ, always intersect in the same point or small square, H.

In a further diagram, the paper exhibits all the roots which arise from applying the *method* to the odd No. 161, and shows that the roots

of A would be	....	3,	2,	16,	16
of W	„	3,	2,	6,	16
of M	„	8,	3,	10,	10
of N	„	7,	2,	12,	12
of AM	„	5,	0,	10,	16
of AN	„	5,	0,	12,	16

It shows the roots of the squares marked B, C, P, Q, R, S, and many others; and, finally, it shows that 161 would be composed of the squares of the following roots, either 3, 12, 2, 2, or 10, 0, 5, 6; but to set forth the roots of the numbers which are in Diagram No. 1, would require a diagram larger than could conveniently be put into a publication of the size of this journal. The roots 10, 0, 5, 6, if arranged thus, $-10, 0, 5, 6$, have 1 for their sum; but it was proved in the former paper (by the same author) that if the algebraic sum of the roots be 1, then the number is the double + 1 of a number composed of three triangular numbers, $161 = 80 \times 2 + 1$, and 80 is composed of the 3 triangular numbers 55, 15, 10. If therefore any number be doubled, and 1 be added, an odd number will be obtained, to which the same process may be applied as is here applied to 161.

I have stated that the cause of the success of "*the method*" (though it does not at present amount to a demonstration) may be easily shown. It arises, first, from "*the method*" requiring every odd number that is a term in any of the series to be represented by the roots of the square numbers that compose it; and secondly, and more particularly, from every series being connected with at least six others of a different kind which intersect it, each of which is again connected with at least five others; so that when the whole network has been pursued, and the roots which in succession form every term have been recorded, it will be found that many different modes of dividing each term into four squares or less will be discovered, *i.e.* if the numbers be large. I propose to show the manner in which the series are apparently interwoven by an example from each kind.

Let the first term in a horizontal series be 22 $\boxed{\begin{matrix} 21 \\ 23 \\ 3, 7, 13, 14 \end{matrix}}$ with 22 as the index in the margin, and 21 and 23 being the indices of the diagonal series which pass through this square; for, except at the top line, two diagonal series pass through every square. 13 and 14 are the variable roots, which become 12, 15, | 11, 16, | 10, 17, | 9, 18, | &c. | in the successive terms; when in the second term 14 becomes 15 $(15 + 7 = 22)$, and the roots are 3, 7, 12, 15, a term in the series which would come down from the second square; the roots in that square will therefore be 3, 12, 4, 4; when 15 becomes 19, the roots will be 3, 7, 8, 19, and the roots at the top will be 7, 8, 8, 8; so when 15 becomes 25 at the tenth term, the roots are 3, 7, 2, 25; and as $-3, 25 = 22$, another series rises up with roots of the first term, 7, 2, 14, 14.

13 diminishes to 0, and then increases, giving 2 more when it becomes 15 or 19; but the series is also crossed by diagonal series; and when the index in the two rows from the first term $\left\{\begin{matrix} 21 & 19 & 17 & 15 & 13, \&c. \\ 23 & 25 & 27 & 29 & 31, \&c. \end{matrix}\right\}$ is 37 (the sum of all the roots), or 31 (the sum of the variable plus the difference of the constant roots), or 17 (the sum of the variable minus the sum of the constant roots), or 23 (the sum of the constant minus the difference of the variable roots), a diagonal series arises. Here are no less than 10 other series by which this is crossed and associated and connected, and the number cannot in any case be less than 6. A series of the second kind gives rise to other series crossing it in the same manner *mutatis mutandis*, which result is so obvious that it is not necessary further to dwell upon it. A series of the

third kind has all the differences of its roots the same in each term. Let

13 $-7,\ 2,\ 4,\ 14$

be a term in a diagonal series at the top row of the system.

Thus:

0	11 8, 13, 2, 2	13 9 2 10 -7, 2, 4, 14	15 6, 15, 4, 4
2	9 9 2 10 -8, 1, 3, 13		17 9 2 10 -6, 3, 5, 15

When it reaches to the left and to the right, the second place, as $3-1=2$ and $5-3=2$, it furnishes two vertical series; at the tenth row it furnishes two more; at the twelfth two more. When it gets into the column whose index is 11 and then 9, before it reaches the margin or outer edge, it furnishes two horizontal series; and after it has passed the margin at 9 and 11 it furnishes two more, and at 21 it furnishes auother. Here are six new vertical and five new horizontal series; besides which it furnishes at least two other diagonal series which cross it.

Having stated the properties which belong to the square, if the first odd number in it be of the form $(4p+2).n+1$, and that whether it be $2n+1$, $6n+1$, $10n+1$, &c., or whatever be the value of n, certain squares may be found to distinguish as A, B, C, H, P, Q, W, M, N, AM, AN, R, S, T, V, &c., which are connected together by a community of roots where the series cross each other in a manner that it is invariable.

The Diagram No. 3 (pl. 302) is another example of the manner in which certain of the terms in the different series communicate with each other, by the roots being common to both, at the point where they cross. AM passes diagonally to *am*, down to *an*, and up to AN. AN, iu like manner, goes down to *an* and up to *am* and AM. If the first term of the square be an odd number of the form $(4p+2).n+1$, the roots from A M are in $an-(2p+1), 1, (n-2p+1), n$. The roots from AN are $-(2p+1), -1, (n-2p+1), n$. The indices of the diagonal series are $\begin{bmatrix} 2n-(4p+3) \\ 2n-(4p+1) \end{bmatrix}$, and the algebraic sum of the roots is the one or the other, according as 1 is + or —; but AM also passes to the series from R, and AN to the series from S, and go to R and S, and thus go up to W. AM also reaches the vertical line from M, and passes up to M, as AN does to N. Lastly AM goes to N thus, and AN to W in a similar manner. Whatever be the values of p and n, these connexions occur, but the form of them varies with the values of p and n.

I have pointed some of the results of having as the first term in the square an odd number of the form $(4p+2).n+1$; the forms will be $2n+1$, $6n+1$, $10n+1$, $14n+1$, &c., in which p may be 0, 1, 2, 3, &c. But there is *another* form which gives similar results, viz. $4pn+(2p+1)$, which is in many respects the "*converse*" of the other; the forms will be $4n+3$, $8n+5$, $12n+7$, $16n+9$, &c. These are the *first terms* to which this system gives rise. The $(n-\overline{p-1})$th term is always $\boxed{p,\ p,\ n,\ n+1}$. In the former system n produced the equal roots and p the unequal; *here*, p produces the equal and n the unequal roots, and I call the $(n-\overline{p-1})$th term A as in the other. This system has also W and M and N on each side of it, and other squares similar to the other, but the roots of which they are composed are differently formed. M aud N come from below. W, instead of being

$\boxed{-\overline{p+1},\ -p,\ n-\overline{4p+2},\ n,}$ will be $\boxed{-3p,\ p,\ (n-2p),\ (n-1-2p),}$

and other terms are similarly altered, but the general result is the same. A specimen of a square of this form is given in another Diagram which cannot be reduced to the size of this Journal, where $p=3$ and $n=16$; the first number is 199, and the square is completed so far as to show that the roots of the 4 squares whose sum is 199 $=$

5,	13,	1,	2
-9,	-3,	3,	10
1,	10,	7,	7

but neither in this Diagram nor in Diagram No. 5 is the whole square completed (to avoid confusion); but if the series be traced in succession, the entire Diagram 5 would be filled up, and every term would disclose the roots whose squares compose it. In this manner every odd nnmber in all the series is divided into the squares that compose it (not exceeding 4), the squares being indicated by their roots.

The two systems of $(4p+2)\times n+1$ and $4p.n+2p+1$ include every possible odd number; $4n+3$ includes every alternate odd number from 3; $8n+5$ every fourth number from 5, and so on; $2n+1$ includes every odd number; $6n+1$ every third odd number. Many odd numbers belong to both systems, and to more than one in each. 151 is an example; it is either $10n+1$ $(n=15)$, or it is $12n+7$ $(n=12)$. The paper contains a diagram (No. 9) exhibiting the odd number 151 as belonging to both systems; but the diagram cannot be reduced. The roots of the squares that compose 151 are (10. 1. 5. 5), or (3. 9. 5. 6).

DIAGRAM No. 6.

$2n-\overline{6p+5}$	$2n-\overline{6p+3}$	$2n-\overline{6p+1}$
M $-\overline{3p+2}$, $p+1$, $n-\overline{2p+2}$, $n-\overline{2p+2}$,	W $-\overline{p+1}$, $-p$, $n-\overline{4p+2}$, n,	N $-3p+1$, p, $n-2p$, $n-2p$.

an interval of $\overline{p-2}$ squares.

$2n-\overline{4p+3}$	$2n-\overline{4p+1}$
AM $-2p+1$, 0, $n-\overline{2p+2}$, n	AN $-\overline{2p+1}$, 0, $n-\overline{2p}$, n,

an interval of $\overline{p-1}$ squares.

$2n-\overline{2p+1}$
A $-\overline{p+1}$, $-p$, n, n

This Diagram (No. 6) is introduced to show in terms of n and p what roots A, AN, AM, N, W, and M contain, and the intervals between them. Each of these in passing downwards to the left is crossed by other series, with which they amalgamate; N may be derived from AN, M from AM; N, W, and M each furnish two others, and these again each two more. When n is small compared with the coefficient $(4p+2)$, W may be on the right of A; for although the series begins at A, and according to the law of the series reaches the 1st square, the same law enables it to continue, with terms whose indice become negative.

Diagram No. 7.

There is an interval of $n-\overline{3p+3}$ squares from the 1st term.

*$2n-6p+4$ R	$2n-\overline{6p+5}$ $-\overline{3p+2}$, p $n-\overline{2p+2}$, $n-\overline{2p+1}$
$2n-\overline{6p+4}$ S	$2n-\overline{6p+1}$ $-\overline{3p+1}$, $p+1$ $n-\overline{2p+1}$, $n-2p$

DOUBLE TYRE TURNING LATHE.

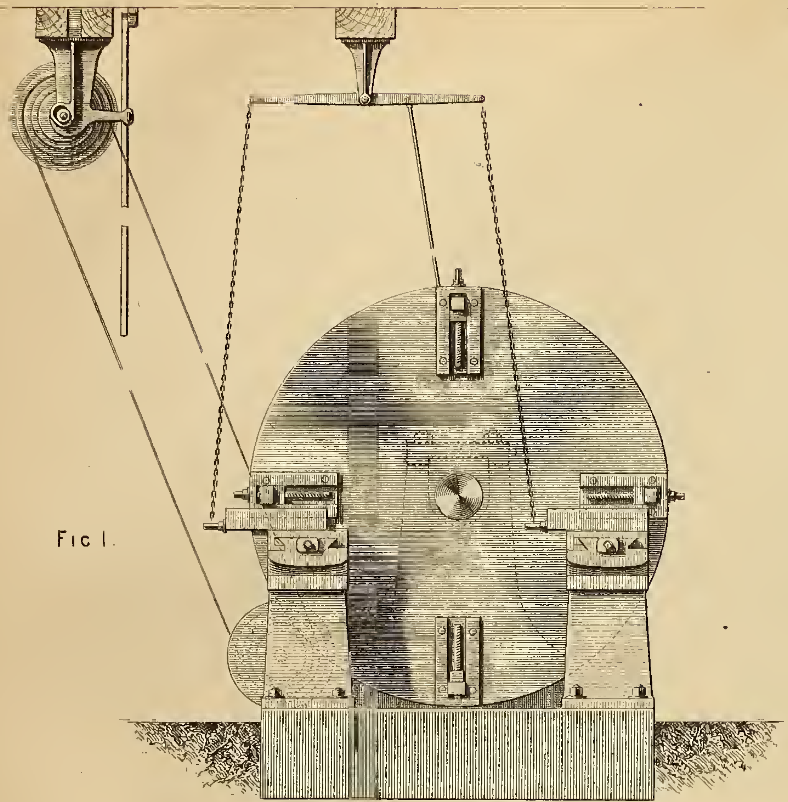

Fig 1.

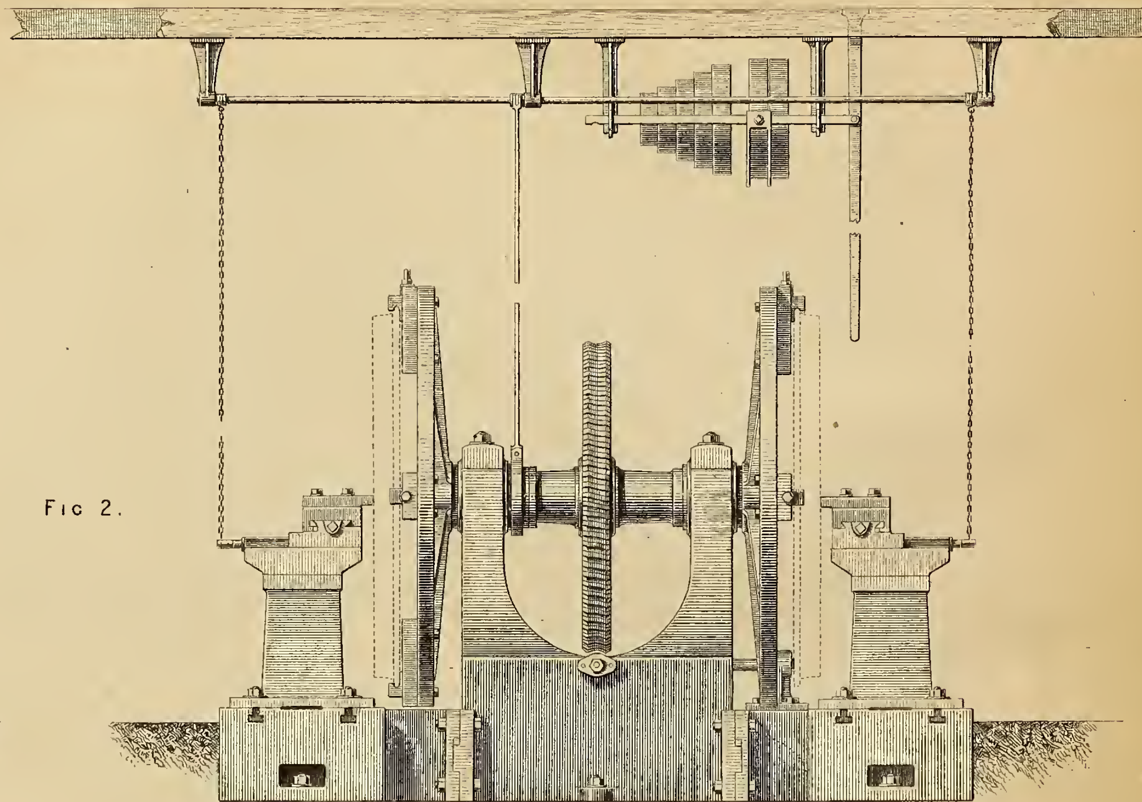

Fig 2.

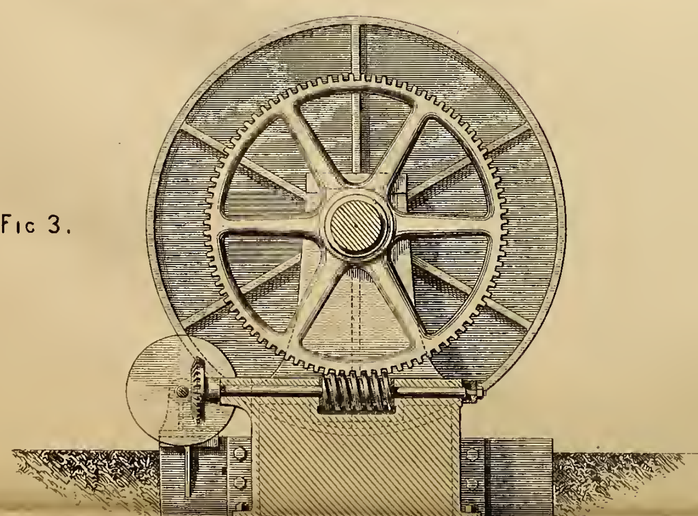

Fig 3.

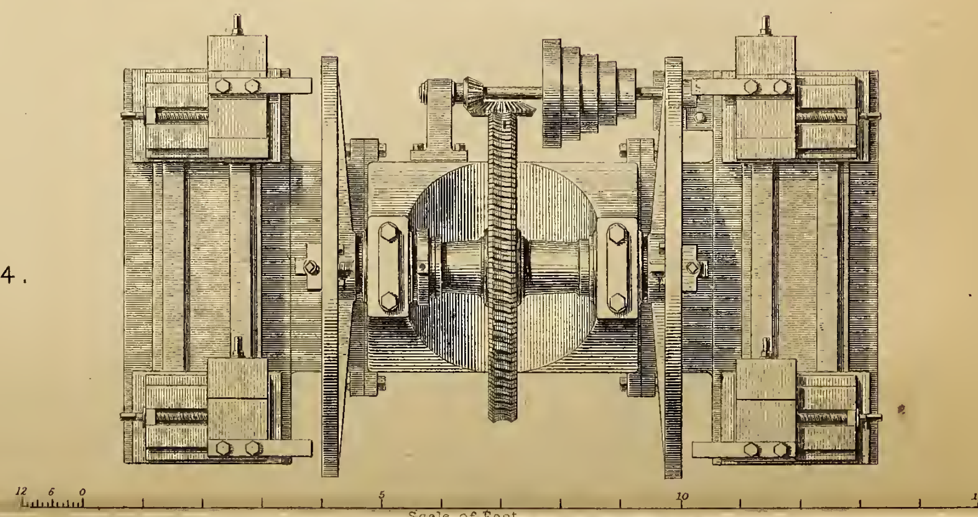

Fig 4.

This diagram (No. 7) shows in terms of n and p the roots of R, S, an (which comes down diagonally from AN), T, and V, and the number of squares between them; the relative positions of these terms depeud entirely on p, and are always the same for the same value of p.

There is here an interval of (p—1) squares from S to an.

$$\begin{array}{c|ccc|}
 & & & 2n-\overline{4p+3} \\
\begin{array}{c} 2n-\overline{4p+2} \\ an \end{array} & & & 2n-\overline{4p+1} \\
 & & -\overline{2p+1},\ 1 & \\
 & & n-\overline{2p+1},\ n & \\
\end{array}$$

Terms similar to these increase indefinitely as n increases. Tbe value of certain roots is independent of n, and therefore is the same for every value of n.

There is here an interval of (p—1) squares from an to T.

$$\begin{array}{c|ccc|}
\begin{array}{c} 2n-\overline{2p+2} \\ \mathrm{T} \end{array} & & & 2n-\overline{2p+3} \\
 & & p+1,\ p+1 & \\
 & & \overline{n-1},\ n & \\
\hline
\begin{array}{c} 2n-2p \\ \mathrm{V} \end{array} & & & 2n-\overline{2p-1} \\
 & & p,\ p,\ n,\ n+1 & \\
\end{array}$$

* [The numbers above the letters are the indices of the vertical series].

AN EXCURSION TO THE CREWE LOCOMOTIVE WORKS.

By J. J. BIRCKEL.

(*Illustrated by Plate* 303.)

We again continue this subject by giving our readers a description of a double wheel lathe, which we have illustrated in the accompanying plate.

Wheel lathes hitherto had been driven by means of a pinion working into a toothed rim, cast or bolted upon the outer periphery of the face plate, and sometimes were provided with a quick motion by driving direct through the lathe spindle, as for instance in Sharp, Stewart & Co.'s 7-tool crank axle lathe lately described among this series; in this case however, Mr. Ramsbottom has entirely left the beaten track, as is his usual wont, and drives the lathe by means of the worm and worm-wheel. The earliest recollection which we have of a machine tool, whose main working shaft is driven by worm-gear, is a boring machine constructed by Mr. Beyer (of the firm of Beyer, Peacock & Co.) for boring out locomotive cylinders, where the object was both to obtain smoothness of motion in the boring bar and fewness of parts in the gearing; and to our own knowledge that machine worked admirably well, so far at any rate as these remarks refer to its driving gear; worm gear, however, has been thought not only to absorb a great deal of power through friction, but also of being subject to rapid wear in the threads and teeth of the worm and wheel, and hence it has not often been employed for the principal working parts of any machine, hut ouly for intermediate or secondary motions, as for instance, in feed motious for slotting, drilling, and shaping machines, and in traversing motions for slide lathes, &c. In the construction of machine tools however the consideration of the absorption of power is of little importance in the combination of parts, as compared with the consideration of simplicity, durability, and adaptation towards the particular result aimed at. As regards durability of the worm-wheel under constant, and what may be termed heavy work, our own observations in connection with the boring machine above-mentioned led us to the conclnsion that when the teeth are properly greased and of a hard description of metal there is no undue wear in them, and Mr. Ramsbottom, who has largely employed the worm and wheel in all his shop travelling cranes, no douht has found such to be the case, or else he would not have made the costly experiment of constructing a wheel-lathe of large dimensions in this manner. In the case before us the obvious advantage gaiued by the use of the worm-gear is to obtain a double lathe by means of a single headstock and a single driving-gear, a combined result which, to our knowledge, had not before been realised.

This lathe, the reader will observe consists of a fixed headstock provided with two equal sized bearings for the spindle, which carries a 7ft. face-plate at each eud; each of these is fitted with four adjustable chucks by means of which the wheel is at once fixed and centred upon the face-plate. Two tool and slide rests are provided for each face-plate so that one mau has the control of four tools working at the same time; these rest upou two short trausverse beds, holted to the headstock at each end. The worm wheel rests upon the spindle in the centre of the headstock, and the worm-shaft, which, of course, rests transversely upon the headstock is driven through bevil gear by means of a strap and cone pullies; these are provided with a number of speeds, sufficient for altering the angular velocity or speed of revolution of the face-plates so as to admit of boring and turning the bosses of the wheels as well as turning the edges and outer circumference of the rim and the inner face of the tyres. The tool rests also are provided with self-acting feed gear worked by an excentric from the lathe spindle.

In our illustration which shows the entire machine with top driving gear in complete working trim, fig 1 is a front elevation showing the face-plate and tool rests; fig. 2 a side elevation; fig. 3 a cross section through the centre of the headstock, the worm, and worm shaft; and fig. 4 is a plan.

The great object which Mr. Ramsbottom has endeavoured to realise in the management of these works is to reduce the expense of labour, by devising mechanical contrivances which enahle him to substitute machine paid labour for skilled artizan labour, and in this praiseworthy object it is well known that he has been emiuently successful; numerous indeed are these minor contrivances to be seen throughout the shops, all of them of no less interest than any complete machine and well deserving to be illustrated in the pages of this journal, if we could hut get drawings of them.

Among these, however, we have picked out one, illustrated in the adjoining woodcut, which has especially arested our attention for its neatness and adaptation to the work, which is to be expedited by it. This tool was contrived for the purpose of shaping the helical regulator guards used in connection with the piston valve, first introduced, we believe, by Mr. Allan, and consists of a hase plate and screwed boss, the pitch of the screw being the same as that of the regulator guards, a quadrant cut in the shape of a worm wheel is screwed on to this boss, the quadrant may he made to revolve upon this boss, by means of a worm and while this takes place it will at the same time be raised or lowered, according to the direction in which it is made to revolve. The whole is holted upon the table of an ordinary shaping machine, and the regulator guard being fixed upon the worm quadrant is cut to shape in the same manner as a plane surface; the worm is worked by the machine through a system of levers and rods, pall and ratchet wheel. The face of the worm quadrant is straight and is rather deep owing to its vertical motion. By means of this little contrivance the gauche surface of the guards is shaped to perfection under the superintendence of a lad or a common machine man, whereas, if cut upon the lathe the operation is exceedingly slow and tedious aud can be done only by a first-rate turner.

IRON.—Another improvement is started in the manufacture of iron, for which a patent has been taken out by Mr. John Onions, of London. This iron is said to be made of ordinary pig iron, and manufactured at a cost of 25 per cent. under that of charcoal iron, and is its equal in every respect as regards quality. Samples have been in various hands for trial, and a uniform success has been the result.

THE FORTH RAILWAY BRIDGE.

We are indebted to an esteemed correspondent, in Scotland, for the following particulars relative to the Forth Railway Bridge.

The delay and inconvenience caused by the intervention of the Forth and Tay Ferries, on the route from Edinburgh to the North, have long been a source of complaint with the public, while the working expenses have been so heavy as to induce the North British Railway Company, who a few years ago became proprietors of the route, to consider whether a more suitable means of communication could not be established. Bridges across the Firths were seen to be the only effective substitutes for the ferry boats; and, gigantic though the task appeared, the directors of the railway resolved to undertake the carrying of the iron road across the waters of the Forth and Tay. Powers were last year obtained from Parliament to proceed with the erection of the Forth bridge, and the works required to connect it with the already existing parts of the North British system; but the Tay bridge is meantime held in abeyance. It was expected that a convenient site for the Forth bridge would be obtained at Queensferry; but though the channel is narrowest at that point, the depth of the water was too great to build in, being 240ft. Another objection, was the fact, that any bridge crossing there would require to be of immense height to allow the passage of the large ships which occasionally seek shelter in St. Margaret's Hope. Mr. Bouch, C.E., engineer of the railway company, sought a site farther up the Forth; and, after careful investigation, selected a point five miles above Queensferry, where the channel is considerably wider, but not so deep. On the south side, the bridge will be connected with the Edinburgh and Glasgow line by a branch extending to a point about mid way between Winchburgh and Linlithgow; and on the north side, a short branch will join it to the network of lines adjoining Dunfermline. A convenient connection will thus be established with the mineral fields of Fife, the importance of which will be much enhanced. Another advantage is, that the journey from Edinburgh to Perth will be shortened by about twenty miles; but this shortening would be due to the bridge in an indirect way only, as the chief curtailment would be made by a line leading from Gateside station on the Fife and Kinross Railway, to a point near Bridge of Earn. For the construction of this line, powers were obtained in 1863, and it will be proceeded with even should the bridge scheme be abandoned.

Though the site chosen for the bridge is, all things considered, the best that could be got on the Firth, it presents engineering difficulties which will require the exercise of the most consummate skill to overcome. The bottom is composed of silt carried down by the Forth, and some of the borings went down through 120ft. of this material. Before proceeding with the entire undertaking, it was resolved to test the practibility of constructing on this soft foundation, and at a reasonable cost, a bridge that would have sufficient stability to bear heavy traffic. To this purpose Mr. Bouch has assiduously applied himself, and he considers that the result holds out a reasonable prospect of success. Preparations are far advanced for commencing the erection of one of the five central piers, according to the plan proposed to be adopted with all the five; and should the experimental pier give satisfaction, the other parts of the bridge will be proceeded with; but if the pier should prove a failure, the undertaking will, there is reason to fear, be abandoned. As the mode of construction employed in the experimental pier possesses some features of novelty, it may be interesting to give a detailed description. In order to obtain a good footing on the silt in the bottom of the Firth, and at the same time, not to give too much weight to the structure, the pier is to have a wood base of considerable extent. This base, which has already been constructed, and launched at Burntisland, may be compared to a huge tray, on the centre of which the masonry of the pier will be built. The tray is composed of logs of Memel timber, firmly bolted together, so as to form a solid mass, 80ft. long, 60ft. broad, and 7ft. thick. Its superficial area is 4,800ft., and the weight it will have to sustain will be equal to 15 cwt. per foot. This pressure is unusually light in such a structure, it being no uncommon thing for the foundation of a bridge-pier to have to sustain 10 tons per foot; but in the case of the Forth Bridge, as already stated, it was necessary to distribute the pressure over a large surface. From the centre of the wooden base the pier will be built up of brick to a height of 12ft. above high-water level; and as the water is 40ft. deep, this will give a height of 52ft. The ground-plan of the brickwork somewhat resembles a figure 8 in outline, the only difference being that it is not so much contracted at the central part. The greatest diameter of the masonry will be 50ft., reduced by stages to 27ft. and the thickness will be 7ft. The brickwork will be built in a caisson, the floor of which is already laid on the wooden platform or base. The caisson will take the shape of the masonry, and is constructed of ½in. iron plates arranged in sections, as to be easily removed when the masonry is finished. As soon as the preliminary arrangements are completed, and a certain amount of the brickwork put in, the base will be towed to the site of the pier, and securely moored between two barges specially constructed for the purpose. Each barge is of 700 tons burthen, and the interior is fitted up as a dwelling-place and workshops for the men to be employed at the pier, while the decks will serve as a platform on which to deposit as required the material for the construction of the pier. After the base is moored in its position, the masonry will be proceeded with; and as the work proceeds and the platform settles down, the walls of the caisson will be carried up gradually, so as always to form a sufficient barrier against the ingress of water. On the wooden base, and placed at regular intervals round the outside of the caisson, are twelve strong iron cylinders, each eight feet in diameter; and in the hollow centre of the masonry, two similar cylinders 12ft. in diameter. These will, like the caisson, be constructed in sections as the pier settles down into the water; and when the platform reaches the bottom, will stand a few feet above the surface at high water. The cylinders are not a permanent part of the work, their purpose being this:—When the wooden base reaches the ground, the cylinders will be loaded with 10,000 tons of pig-iron, which is two and a half times the weight that the pier will have to bear when the superstructure is completed, and a train standing upon it. It is calculated that this weight will be sufficient to press the pier into the silt to a depth of six or seven feet, so that the surface of the wooden base will be nearly level with the surface of the silt. Once this is effected, the cylinders will be emptied and taken up; and the masonry having by this time reached the surface, and be allowed time to consolidate, the walls of the caisson will be removed, and, with the cylinders, applied to the construction of the next pier. The cylinders will also be used for another purpose than that described. When the platform settles down, it is possible that it may not take a level position, in which case, men can be sent into the cylinders to excavate, through ingeniously contrived openings, some of the silt on the high side or end. After the base has been adjusted in this manner, a large quantity of slag will be deposited on and around the wooden platform, and as this consolidates, considerable strength will be imparted to the substructure. Above the low-water level the piers will be faced with whinstone, and on a platform of that material the columns of the bridge will stand. The principle of construction adopted in the pier, is similar to that which was followed in the case of the old Westminster bridge.

Leaving the Experimental Pier completed, so far as the masonry is concerned, we shall now proceed to describe the bridge as it will appear when completed, if it ever be so. The entire length of the bridge will be 3887 yards, or about two miles and one-fifth; and it will be supported on sixty-one piers. Commencing at the south side, there will be fourteen openings of 100 feet span, six of 175 feet, fifteen of 200 feet; then come the four great central navigable openings of 500 feet each, next two of 200 feet, four of 173 feet, four of 150 feet, and twenty of 100. The height of the openings will gradually rise from 65 feet at the sides to 125 feet in the centre above high-water level. The abutments will consist of 30 yards of stone arching on one side, and 94 yards on the other. The piers of the spans on either side of the four central openings, will be of simpler construction than those described above. Each will consist of four cast-iron piles, two feet in diameter and one inch thick, arranged in pairs, and protected by a malleable iron pile, of similar diameter, placed on each side. These piles are furnished with disks at the lower end, which will be embedded to a considerable depth in the silt. At the low-water line the piles will be united by a platform, which will form a base for the columns on which the girders will rest. Each pier will sustain two columns, compose of cast-iron, 10ft. in diameter, 1in. thick, and built up in lengths of 10ft. The girders which are on the lattice principle will be immense structures, especially the central ones. Each of the four great girders will weigh 1170 tons, which is 592 tons less than the weight of the tubes of the Britannia Bridge, though the span is 40ft. more. The depth of these girders will be 64ft., and the width between their sides 18ft. There will be no cross-girders, the fabric being sufficiently strengthened by overhead lattice work, and a flooring of wood one foot in thickness. This flooring will be a few feet above the lower edge of the girders over the four great openings, but on either side of these the form of the bridge will undergo a change, so that while in the case of the central openings the train may be said to run along the bottom of the girders inside, in the case of the side openings it will run along the top. The object of this arrangement is to increase the height of the central openings, so that the largest vessels may be able to pass through; and this having been provided for, it would be unnecessary and inexpedient to carry the side girders to a greater height than would be required to allow their upper sides to reach the level of the rails which pass through the centre girders. Over the smaller openings the weight of the girders will be much reduced, and will diminish towards either end of the bridge. The girders will be constructed on land, and floated on pontoons to their respective piers. The work of elevating them to their lofty positions will, as may be imagined, be a work of great difficulty, and will require special and novel appliances. As the girders or sections are put up, they will be joined, so as to form one continuous web of iron from side to side of the Firth. By this plan great strength will be given to the bridge. The greatest height

from the base to the summit of the bridge will be 212ft. From the difficulties attending the construction of the five central piers, it is not expected that they can be completed in a shorter time than four years, and of course a considerable time longer will be required to finish the work. The estimated cost of the bridge is £476,543, of which sum £267,105 is allowed for the four central spans. No contract has been entered into for the construction of the pier, nor will there be any until the result of the experiments at present in progress becomes known. The iron work required for the caisson and cylinders has been supplied by Messrs. Hopkins, Jilkes & Co. (Limited), Middlesbro'-on-Tees; and the wood platform has been put together by workmen connected with the railway.

THE PAST AND PRESENT PRODUCTIVE POWER OF COTTON MACHINERY.

(*Continued from page* 138.)

PART I.—*Mediæval History*.—(Continued).

Weaving looms moved by machinery, or what are called power looms, are now become objects of considerable importance. These were constructed with great ingenuity, and with some prospect of success, so early as 1774, by Dr. Cartwright, at Doncaster. Dr. Cartwright's looms made good cloth, but so much time was lost in dressing the warp in the loom that they on the whole possessed no important advantage over the common looms. In 1803, Mr. Thomas Johnson, of Bradbury, Cheshire, invented a beautiful and excellent machine for warping and dressing warps, preparatory to weaving, by which this operation is performed much better and cheaper than it can possibly be done by hand. It is now known by the name of Radcliff's dressing machine, from the unremitting exertions of that gentleman to have it made effective. This is a great advantage to power looms, for without it they never could have been made practically useful, and during the last ten years some large manufactories for their use have been established, first in Scotland and afterwards in England. It is found, however, that one person cannot attend upon more than two power looms, and it is still problematical whether this saving of labour counterbalances the expense of power and machinery, and the disadvantage of being obliged to keep an establishment of power looms constantly at work; whilst, in the common way, the looms might be stopped, or turned to a different kind of weaving, if the demand for the particular kind of goods they were weaving should change or fall off. Several improvements in the construction of power looms have lately been brought forward, and some of them appear to have important advantages over any other construction that has hitherto been in use. Their real value, however, can be determined only by time and experience. It should be recollected that thousands of ingenious contrivances have been tried and laid aside, before spinning machines were brought to their present state of perfection. Without entering into details, I may observe that their united effects amount to this, that the labour of one person, aided by them, can now produce as much yarn in a given time as two hundred could have produced fifty years ago. Having taken some pains to ascertain the present state of the cotton manufacture as far as regards the spinning of the articles, I apprehend it may be acceptable to have the result subjoined. In 1817, from authentic documents and the best estimates I could draw from them, the quantity of raw cotton consumed or converted into yarn was:—

	lb.
In Great Britain and Ireland	110,000,000
Loss in spinning, estimated $1\frac{1}{2}$oz. per lb.	10,312,500
Quantity of yarn produced	99,687,500
Number of hanks (supposing the average to be 40 per lb.)	3,987,500,000
Number of spindles employed (each spindle being supposed to produce two hanks per day, and 300 working days in the year)	6,645,833
Number of persons employed in spinning (supposing each to produce 120 hanks per day)	110,763
Number of horses' power employed (supposing $4\frac{1}{2}$oz. of coal to produce one hank of No. 40, and 180lb. of coal per day equal to one horse's power)	20,768

It may here be recorded that a son of Kay, the inventor of the fly-shuttle, was the inventor of the drop box in the loom, by means of which the weaver can at pleasure use any of seven shuttles, each containing a different coloured weft, without stopping the loom. Ure says:—"Continuity of action is an essential principle of all mechanisms impelled by the force of steam or running water, while alternate effort and repose are the characters of human labour." Hence the interruptions in the movements of the shuttle which take place while the weaver is dressing a certain portion of the web, and which serve to diversify his labour, would be intolerable in a factory where power and time must be economised to the utmost. It became, therefore, a matter of primary importance to combine with the automatic loom an automatic dressing machine. By the commencement of this century, the mechanism of the power loom had been so far perfected by rival inventors, as to demonstrate its practical value, provided a good system of dressing the chain or warp could be devised. This want was not long of being supplied. In 1804, Mr. Johnson, of Stockport, obtained a patent for a method of dressing a whole web at once by a self-acting machine. An improvement was made upon it by Mr. Macadam, in 1806, which was immediately realised on a considerable scale in Mr. Monteith's weaving factory at Pollokshaws, near Glasgow. This was probably the first web-dressing mechanism which continued to give satisfaction to the manufacturer during a series of years. Certain defects in this apparatus were, after a little while, removed by the warp dressing machine of Messrs. Ross and Radcliffe, of Stockport. The Chambers of Commerce of Manchester were so much convinced of the value of the improvements introduced by these gentlemen, that they forwarded a memorial to the Lords of the Treasury, soliciting a reward to the ingenious inventors. In that memorial they stated "that the effects of the new method have been to bring the whole process of the manufacture (of cotton) from the raw material to the cloth into one connected series of operations, by means of which a cheaper, more uniform, and better fabric has been produced. That for introducing this greatly improved system, the public is indebted to the persevering efforts of Messrs. Radcliffe and Ross, of Stockport, who, it appears, had expended their whole capital in bringing it to maturity, and were, in consequence, unable to remunerate themselves by the use and application of their own plans. That Messrs. Radcliffe and Ross, are, therefore, in the opinion of your memorialists, justly entitled to be recompensed by the public for the advantages derived from the adoption of this system." From a letter addressed to the Lords of the Treasury by Mr. Radcliffe, in June, 1825, it would appear that the prayer of the above memorial was unsuccessful. It was not till Horrocks, of Stockport, in 1813, after a long, laborious, and most costly career of experiment, introduced some very important modifications into the power loom, that it began to act any considerable part in our cotton manufacture. Horrocks, however, did not reap the reward due to his ingenuity, having omitted certain minutiæ in the construction of his machine, which interfered with its uniformity of performance, and thus allowed the prize of excellence to be won by his successors. His power loom is described with figures in the "Repertory of Arts and Manufactures" for 1814. On that basis Messrs. Sharp and Roberts afterwards made their well-known looms. Mr. Roberts obtained a patent in November, 1822, for a power loom having six heddles, adapted to weave twilled cloths or fustians, and such other fabrics as have the threads crossed in weaving in that particular manner called twill. Mr. Robert Bowman, of Manchester, had, in January, 1821, obtained a patent for an ingenious power loom calculated to perform several of the functions assigned to that of Mr. Roberts. The patentee observes, that the manner in which power looms had been hitherto constructed did not admit of employing so many heddles as were requisite for weaving those kinds of fabrics called fustians, such as velvets, velveteens, corduroys, &c. which are of the nature of twilled or tufted cloths. He describes his improvements as consisting of such simple modes of harnessing the heddles of power looms, and of applying the tappets or wipers to draw down the heddles, that he is enabled to manufacture the before-described cloths by power looms, with the same facility and perfection that they could be produced by hand weaving. Mr. William Horrocks, formerly of Stockport, afterwards of Portwood, in Cheshire, of whose improvements mention has been made, obtained a patent in December, 1821, for an invention which consisted in adapting an apparatus for the purpose of wetting the warp and weft at stated intervals during the process of weaving. He placed an oblong trough, containing water, or a solution of soap and water, across the loom under the warp, which he applied by a rod or bar covered with cloth, which was made by two short arms, alternately to descend into the trough and rise up to the underside of the warp, thereby conveying a small quantity of the liquid both to the warp and weft, so as to moisten them, and thereby enable the weaver to compress in the fabric any quantity of weft that might be required. Messrs. Stansfield, Briggs, Pritchard, and Barraclough, of Leeds, or its vicinity, obtained a patent in July, 1823, for three improvements upon power looms, the first two being peculiar modes of delivering the warp as it is needed, and the third a method of increasing and diminishing the tention of the warp, at intervals, for the purpose of assisting the operation of weaving. In June, 1824, Mr. W. Harwood Horrocks, of Stockport, obtained a patent for a newly-invented apparatus for giving tention to the warp in looms, consisting in a method of restain-

ing the delivery of the warp by the friction of a hoop which embraces a wheel at the end of the beam. Mr. John Potter, of Smedley, near Manchester, obtained a patent in May, 1825, for the "Invention of certain improvements in power looms for weaving various kinds of figured fabrics." An improved method of making heddles, by Mr. John Rothwell, of Manchester, became the subject of a patent in January, 1826. He proposed to make the loops of the heddles double, that is, passing over the shafts at the top and bottom, and meeting both at the back and front, and also that they should be formed of long and short loops alternately. By these means the knots of the one series of loops will be a little distance above the knots of the other series of loops, and the warp threads will be enabled to pass each other with greater freedom, and of course with less friction, the space for the warp being open in the middle. A curious contrivance of Messrs. Stansfield, Pritchard, and Wilkinson, of Leeds, was secured by patent in July, 1825. It consists, first, in a small appendage to the shuttle, by which, in the event of the weft thread breaking, the shuttle is arrested in its race, and the actions of the loom stopped; secondly, in an apparatus attached to the back of the lay, for the purpose also of stopping the shuttle when any of the warp threads breaks. Mr. T. R. Williams, under a patent obtained in February, 1830, proposed to substitute, for the warping mill, a creel, containing a series of bobbins connected with the warp-beam end of the loom, whose threads are passed round two different friction rollers before they proceed in the horizontal warp-plane, towards the heddles; the invention evidently foreshadowing the present successful beam warping mill. The early series of inventions which gave energy to the English cotton manufacture may be said to have been completed about 1780. Before their introduction—namely, until 1751—the import of raw cotton into this country had gone on increasing, but with a slow, heavy step; the supply being, in 1701, 1,985,868 pounds, and in 1751, 2,976,610 pounds. In 1780 it had increased to upwards of 6,700,000 pounds; in 1790, the import reached 31 millions and a half pounds; in 1800 the import was 56 millions, and in 1830, 239,837,350, or nearly 240 million pounds. The increase during the 70 years, from 1760 to 1830, is thus shown to have been about 70-fold.

Part III.—*Modern History.*

From 1830 to 1860 the productive power of cotton machinery has made, and will, I believe, continue to make, considerable progress, chiefly through the increased skill of our ingenious machinists, which is ever being urged on by the keen competition in the cotton trade to make the machinery as automatic as is possible, and at the same time to increase its productive power for quantity combined with quality. We find that during the thirty years ending with 1860 (the unfortunate cotton famine making any later date useless for our inquiry) in the blowing room considerable improvements have been made by making the machines entirely of metal, instead of being part wood and part metal; by a much more suitable arrangement of the different points of working for cleaning and producing a perfectly level lap (for this latter object Lord's patent feeder is most excellent); by having down instead of up draughts; having solid arms and steel blades to the beaters; by having cannon bearings instead of brass steps; and by the application of Mohler's patent for lubricating the bearings, and by its use entirely preventing heated bearings (a source of frequent stoppage of the machinery in former times). And here let me remark my surprise at the non-adoption to every lap machine of an invention by Messrs. Dobson and Barlow, of Bolton, by means of which a clutch-box on the side shaft is so placed that in the event of any foreign substance going between the feed rollers and coming in contact with the beater and thus causing a fire or the loss of a human hand (both of which I have seen from that cause), the clutch-box can be at once opened and the feed rollers stopped in a second of time, before any or much harm has been done. I certainly think no blowing or lap machine should be allowed to work without the application of this simple, but valuable, invention. In 1830 the blowing-room was filled with dust and loose particles of cotton floating in the air, and decidedly the most unhealthy place in a cotton mill; whereas now it is as clear in its atmosphere as any other room in the mill, thereby greatly prolonging the lives of the workers. The same remark also applies to the cardroom to a large extent, for in every well-conducted mill the cardrooms are well ventilated, either naturally, or artificially by means of fans or pipes. While speaking of the ventilation of mills, I may here say the mills built during the last dozen years are much loftier in the rooms than was the case in the old mills, the rooms in the new ones being usually 3ft. to 4ft. loftier than in the old ones, thus giving about 30 per cent. more breathing room. In the cardroom the carding engine has been wonderfully improved and especially during the last six years. In 1830 the carding engine was small, mainly of wood, and covered by stripping flats (the latter causing the loss of much cotton, and that at a considerable cost in wages); while now the engines are chiefly of iron, and larger; a main cylinder, for instance, instead of being 30in. in diameter by 30in. wide, with 2,700 square inches of carding surface, has now a diameter of 44in. by 44in. giving a carding surface of 5,808 square inches, or more than as much again. In addition to that, the flats are now dispensed with (excepting for counts above 50's) rollers and clearers being employed instead, to the great saving of cotton, increased quantity, and less cost. As an illustration, take the case of a mill in Manchester, where recently Messrs. Hetherington and Sons, machinists, have taken out 189 engines of the old make, 24in. on the wire, and replaced them with combing machines and fifteen engines 40in. on the wire, which are now carding more cotton per week, of as good quality, and at an immense reduction in the cost of production as compared with the product of the old 189. This enormous increase of productive power is further illustrated at a new mill and shed in Carlisle, where £30,000 have produced mills and machinery for one of the vice presidents of this association, the best that skill and money could produce; while, in 1830 nearly twice the size of mills and quantity of machinery, at an outlay of £50,000, would have been required to produce the same quantity and quality of yarn and cloth, the cost of production being, in the case of the new works, little more than half the cost per pound, and yet an increase in wages to each worker of fully 50 per cent., and that, too, for ten and a-half hours per day instead of twelve hours, and sometimes even more, in 1830. I can here but notice other improvements in the carding engine which have had a share in this increase of production, viz. self-acting strippers, better clothing (especially india-rubber clothing) greater working surface by keeping as low as possible the licker-in and doffer, metallic clothing for the former, a doffing knife motion making 2,000 strokes per minute, and the addition of a coiler. The drawing frame, in consequence of now having stronger framing, greater length of roller bearings, the invention of the coiler and of the stop motion, and other improvements, is capable of producing an increase of 60 per cent. of first-class drawings. Sir Richard Arkwright, the inventor of this frame, was so impressed with its importance in spinning, that when any bad work was turned out he immediately desired his workers to "mind their drawings." The slubbing and roving frames being one in principle—one being simply larger than the other—will be treated of as one frame. Next to the jacquard loom and the self-acting mule, the roving frame is the most ingeniously arranged frame in a mill. In 1830 it produced 8½lb. per sixty-nine hours of a four-hank roving; now it produces, on Higgins and Sons' frames, as also on those made by Mason, 14lb. in sixty hours per week; while one hand can now mind 300 spindles with greater ease than her mother in 1830 could manage 150. This increase is mainly due to increased strength of framing, more accurate and finished workmanship, the invention of the spring presser (now being superseded by the centrifugal presser), stronger and better arranged gearing, and very largely to an increased length of bearing in the spindle collar, from 3in. to 12in.; thus enabling the spindles to run 1,400 revolutions per minute, instead of 600, as in 1830. The throstle frame has made less progress in increased quantity than any other frame in cotton spinning since its invention. As compared with 1830, the increase may be taken at about 30 per cent., mainly due to greater length of spindle collar, stronger framing and gearing, and better workmanship in construction. In consequence of these improvements, a young woman can now easily "tent" (attend to) twice the number of spindles which could be tented by one worker in 1830. The mule, both hand and self-acting, has made great progress during the thirty years prior to 1860. The productive power of the hand mule has not increased much per spindle, but in quantity per spinner the increase may fairly be taken at 200 per cent., in consequence of increased length of mules, double and treble decking (or coupling) of short old mules, and the many excellent appliances which have been introduced into the headstock to save weight and bodily labour on the part of the spinner. The self-acting mule, in its present successful form, is entirely the creation of the thirty years under consideration, and is as much due to the genius and industry of the late Richard Roberts as was the hand mule to Crompton. While I admit that several other mules of this class were brought out by Potter, Smith, and others, yet I say that the principle of the self-acting mule now almost universally made, was developed by Roberts, and that future ages will associate his name with that form of mule just as certainly as it will that of Arkwright with the water frame, Hargreaves with the jenny, Crompton with the hand mule, and Kay with the fly shuttle in the loom. The production of a self-acting mule in 1860 would equal 1lb. per spindle, 24's being the counts of yarn spun, as against a little over half that weight per spindle from the hand mule in 1830. But when it is noticed that, instead of a hand mule with 400 spindles, we have a self-actor with 900 spindles, it will readily be seen that an immense step has been made in mule spinning during the years since 1830. The power loom in 1830 was of very rude construction compared with the present loom. The framing and working parts were badly proportioned as regards strength, being far too weak in some of its movements, and much too heavy in others, which consequently caused irregularity in working and weaving cloth.

(*To be Continued*).

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. PEACOCK, Jersey.

(*Continued from page* 150.)

CHAPTER II. (*Continued*).

32. It will now be convenient to continue the quotation from Mr. Poingdestre's M.S., commencing at the point where it was interrupted in Article 15:—"But of lato years, within the memory of most men, two great rocks lying one behind the other in the sea at a place called Le Hoc, in St. Clement's parish, the nearest of which is severed from the land a bowshot at full sea, were *ioyned to it*,* and served many men yet alive to drye vraic upon; *which in former times was the fate of a great tract of land neere Mont-Orgueil Castle, called le Banc du Viellet, which appeareth above water at halfe ebbe, like an island, at some distance from the maine land.* As for the sands, because the hurt from them is caused by westerly winds (which blowe the greatest part of the year in these islands), and drive them from the seawards upon the land, theire disaster is not seen but in the westerne parts, and espălly in the parishes of St. Ouen and St. Brelade; but greater in the last, even at the very top of it, which of a long time is utterly covered therewith a great depth, that it is hideous to behold, and of no use or profit at all, being above the third part of that parish. Not to speake of the harme don by those sands in yᵉ parish of St. Helery from yᵉ very town to yᵉ bulwark of St. Lawrence, which is not a little; all yᵉ bay of St. Ouen, *formerly full of meadows and good arable ground*, is within these fewe years quite spoiled by yᵉ sands, from the sea to the very hills, and become of noe value. The fabulous reports which have hen concerning the cause of those sandy banks are not worth being any more published." † It will now be necessary to interrupt the quotation again to produce farther evidences.

33. A few hundred yards east of the Hot Sea Baths, on the south coast of Jersey, is "the new slip," or inclined paved slope across the beach, for the convenience of carts passing to and fro between land and low water. Measuring along a line parallel to the outside edge of the top of the coping on the western side of this slip, and 17ft. distant westwardly from the said outside top edge, for a distauce of 922ft. from tho wall which forms the north boundary of tho beach southwards, you arrive at the roots of a largo tree, probably an oak, lying prostrate and imbedded in the sand. The roots are on the south, and the top towards the north, the length of the remains of the tree is 19ft., the diameter above the roots 2ft. 4ins. A thick fragment of root projects on each side at the extremity. The trunk of the treo is by spirit level 22ft. below greatest high water. It is probable this tree grew where it lies.—July 17th, 1865.

34. A few hundred yards farther east than this tree, about two or three years ago, Mr. Rose, the proprietor of the Baths, states that he saw four small trunks of trees in an upright position, at about the same distance from the north side of the beach, and that he has a portion of one of them in his museum.

35. In March, 1864, Mr. John Aubin, of St. Clement's, had his boat-load of vraic unloaded into a cart near the two great rocks at Le Hoc, mentioned by Mr. Poingdestre, and the cart had nearly been upset in consequence of the wheel running against the stump of a tree, of which there were two or three about 12ft. below high water, and 50 yards north-east of the nearest of the said rocks. These stumps of trees were afterwards removed by order of Mr. Le Mare, the Constable. The locality is immediately south of the New Pontac Hotel.

36. At or near Grand Roque, which is on the south coast, near the south-eastern extremity of Jersey, there are said to be other stumps of trees, but the writer has not seen them. All these four places are parts of the Banc du Viellet. At Grand Roque, or La Roche, as we shall see in the next article, there were once a church and village called Luneville, which have now totally disappeared, and which must have stood upon the Banc du Viellet. The Banc extends two miles south and two miles east into the present sea, from the south-east angle of Jersey, therefore "that great tract of land," when it *was* land, gave a coast line considerably nearer France than at present. We shall also find the French coast extending farther *west*, and other far more striking circumstances. I cannot depend on tho hydrographical accuracy of any of the ancient maps, and, therefore, do not refer to them as authorities; they will, however, be referred to more particularly, that the reader may know what maps are meant and their dates.

* The Italics are by the present writer. These rocks still exist, the tops covered with grass.

† This, and the whole of the two sentences preceding, refer not to any sinking of land, but to its becoming covered with drifted sand. But the latter is the direct consequence of the former events. For when the vegetation had decayed on the sunken tracts, after they had been for some time daily covered by the tide, there was nothing to prevent the sand from drifting.

CHAPTER III.

THE ECREHOUS AND DIROUILLES.

37. The Ecrehous islets are six English miles north-east from the north-east angle of Jersey. Maitre Isle, the principal islet, is now very small; by measurement on May 20th, 1864, it was found to contain only 2a. 2r. 15p. within high-water mark, of which part is entirely destitute of soil, and there are only 2a. 0r. 34p. productive. Its highest point is stated in the late Admiral White's "Sailing Directions," 1846, p. 223, to be 36ft. above high water, though it did not appear to the writer to be so much. The island produces only grass and a quantity of luxuriant plants of the *Lavatera arborea*, or sea tree mallow. There is neither shrub, nor bush, nor any fresh water. Its extreme length and breadth are 188 yards by 100 yards. It contains a few huts for the temporary occupation of those who go to gather seaweed and to catch lobsters during a few weeks of summer, also parts of two walls which once formed an angle of the ancient chapel. The whole group of the Ecrehou rocks (for the rest are mere rocks without soil) is about 3 miles long from east to west, and nearly 1½ mile from north to south; and at a little distance to the westward commences another group of naked rocks called the Dirouilles, occuping a nearly circular space of about 2 miles in diameter. Maitre Isle must necessarily have formed part of a much larger island within the last six centuries, for various reasons. For though it is now not fit for being permanently inhabited, for want of wood and fresh water, which are not to be had at a less distance than six miles, and on account of its smallness, it had once a sufficient number of inhabitants to induce the diocesan to send two monks to celebrate mass daily in the chapel; because, as the Rev. G. J. Le Maitre well observes, at S. Lo, in the Archives is a parchment referring to the tithes to be received from the curè of the "parish" of the Ecrehous in Jersey, from which he justly infers that, as it was a *parish*, there must necessarily have been *cure of souls*, and consequently *inhabitants*. And there is also, he says, another parchment referring to a village and church of Luneville, in the parish of Grouville at la Roche (ad rupem). These have been referred to in the previous article.

38. Only one angle of the chapel of Maitre Isle now remains; the site of the rest of the building has been destroyed by the tides, which prevents any judgment being formed of its original extent. The late M. de Gerville, of Valognes, a learned antiquary who studied western Normandy for forty years, and copied five or six thousand pages of records of cathedrals, monasteries, chateaus, and hospitals, published a pamphlet entitled "Recherches sur les Iles Normandes du Cotentin en général et sur la mission de St. Marcouf en particulier." In this pamphlet he says that one of the Ecrehou isles "was in 1203 sufficiently considerable to contain a church in which mass was to be said every day; which in 1327 had still a chapel of our Lady of enough importance to cause the abbot of Val Richer to have it served by two monks; which in 1687* presents still the ruins of this chapel, and which in this day has ony its ancient name given to uncultivated and uninhabited rocks. The rest has been swallowed up by the sea." And giving the following reference, "Ex Gall. Christ., t. xi., Inter Instrum. Ecc. Bajoc., col. 94," he quotes in the pamphlet (which is without name or date, but which was printed by

* I saw at the British Museum Marriotte's Map of this date, which shows the chapel about the centre of the Isle. The Map is on a very small scale.

the late Messrs. Falle, of Royal Square, Jersey, within the last twenty years), a copy in Latin of a charter dated 1203, by which Peter de Pratel gives to God and to the monks of the Church of Holy Mary of Val Richer, for the salvation of the soul of John, the illustrious king of England, who gave him the islands, and for the salvation of his own soul and those of his father and mother and all his ancestors, the isle of Escrehou in its entirety to build there a church (basilicam) in honour of God and blessed Mary, so that divine mysteries may be celebrated there daily, and the abbot and monks are also to possess whatever they shall be able to build up and erect in the said island. And he also grants to them whatever may be given to them in charity by his men of Jersey, Gernesey, and Aureney, and confirms his grant in the presence of eight witnesses named and many others.. In the same volume of Gallia Christiana, M. de Gerville says it is recorded in col. 447 that Gabriel . . . , abbot of Val Richer, sent two monks in 1337, on Thursday before Palm Sunday, to keep and preside over the chapel of Blessed Mary of Escrehon. This is the last we hear of the practical use of this church or chapel. The original Latin is quoted in my M.S. appendix, but it would not be fitting to load the columns of The Artizan with it.

39. In a book of the King's rents in Jersey, made in August and September, 1607, by Sir Robert Gardner, knight, and James Hussey, —now in possession of F. G. Collas, Esq., of St. Martin's—folio 5, is an account of wheat rents due for Ecreho from the heirs of Jean le Hardy, gent., and others, which corroborates the fact of there having been a priory or chapel in Ecrehou, for he gives a list of wheat rents "due for the Priory of Ecreho payable yearly in manner and forme as the aforesaid wheats of the Daughter of Carteret," &c., namely, from John Grey, John Hubert, and Edward la Cloche—in the whole V cabots.

40. One of the boatmen who rowed the writer to Ecrehou on May 20, 1864, namely, Thomas Biampied of Rozel, stated that he had seen, in 1861, a stump of a tree which he thought stood where it grew, about 300 yards east of the rock called Gros Tète, about 41 feet. Gros Tète is about half-a-mile north-west of Maitre Isle. Joseph Blampied of the Glory Inn, Rozel, also a boatman, has seen stumps of trees fixed in the gravel about at extreme low water between le Viél rock and le Bècus; these rocks are somewhat farther to the north-west than Gros Fète. In sailing amongst the rocky islets of the Ecrehous, it was observable that there was not a sufficient amount of gravel banks to account for the land having been washed away. The only gravel bank lies about half a mile north of Maitre Isle, in the island Marmotiére which consists of two barren rocks (the southerly rock is granite containing minute specks of silver, and has several huts upon it). A ridge of gravel extended from one of these two rocks to the other at the date named, and was triangular in cross section, and was estimated to contain about 12,000 cubic yards of gravel. Every storm alters the form and position of this bank, which appears to be entirely inadequate in bulk, to justify the belief that the island has been washed away; and if it had been washed away, it is quite impossible that the stumps of trees could have remained sticking in the bottom. If we suppose it to have sunk upwards of 41ft., the stumps of trees would previously have been above high water, where they doubtless grew, and the island would have been large enough to have produced both wood and water, and it would have been habitable and worth inhabiting. It is certain that without a much larger and loftier "gathering ground" than there is at present; there never could have been a sufficient supply of fresh water. It will be seen that these reasonings, which naturally arise from the premises, are confirmed by the actual facts narrated in Article 41, where it is stated as a matter of history, that in consequence of a certain catastrophe in 709. Chausy became an island, *so did the Ecrehous, but of a very great extent which it has not maintained.** From about the year 860, as we also gather from Article 41, to about the year (suppose) 1356, there can be little doubt that the Ecrehous and Dironilles formed one considerable island. The present sea being very shallow amongst the islets, the island, or islands, would necessarily before sinking, have contained some hundreds of acres at least. The last date of sending monks to the chapels, namely, 1337, admits the belief that it was submerged about, and perhaps exactly, at the same time as the forest of St. Ouen's. In fact Poingdestre's expression is "within these 350 years," meaning that it was less than 350, which is quite consistent with the belief that the sinkings at the Ecrehous and Dironilles, as well as those on the south and west of Jersey, may all have occurred in 1356.

* Lecanu's Evêques de Coutances, p. 448.

41. In the vast researches which Lecanu, in his preface, describes himself to have made (and which are detailed at length in my MS. Appendix), for the purpose of his *Hist. des Evêques de Constances*, whilst he places in 709 the principal submersion of the Forest of Sciscy, he says:—"Yet it was not till the year 860 that the forest was totally submerged; then the isles of Jersey, Guernsey, and Alderney found themselves very much farther separated from the continent than before; Chausey became an island, *so did the Ecrehous*, but of a very much greater extent which they have not maintained." Lecann is, at any rate, an unprejudiced witness as respects the sinking, for he had no notion of anything of the sort. For he attributes the submersions only to a "south-west wind which blew constantly for many months with great violence, and accumulated the waters of the ocean in such quantity "on our shores, that the [equinoctial] tide of March, assisted by all its impetuosity, overpassed the ordinary limits and over-ran a vast extent of country."! Causes, it need scarcely be said, totally inadequate to the effect.

The Word "Hou" and its Signification.

42. Amongst the Channel Islands, some of the islets, now too small and rocky to be inhabitable, have as part of their names, *hou* or *ou*, which according to M. de Gerville, in the Teuton or Danish language means "house." M. Edouard le Héricher too in his Glossary on Germanic Origins, says that *hou* is a common affix to topographical names in the sense of habitation, the "house" and he gives examples Néhou, Quelkhou, Pirou, Bléhou, Libou (rock of Granville), Titahou (isle of).

If these things be so, the fact is very significant. For then we have Ecre*hou*, or the Ecre-"houses." Dir-*ou*-illes, or "the house-isles. Also Brecq-*hou* near Sercq, Bur*hou*, near Alderney, Jet*hou*, near Herm, and Li*hou*, west of Guernsey. Plainly meaning that there were once plenty of *houses*, and, consequently, of *inhabitants*, in the places named, where there is now *scarcely either house or inhabitant.** M. de Gerville (in effect) concurs, and he further says as follows:—

"Mais pourquoi, dira-t-on, ces terminaisons sont-elles affectées aux plus petites îles, tandis que les plus grandes, comme Guernesey ou Jersey, conservaient le leur? C'est suivant moi, justement parce que les grandes îles avaient conservé une population plus étendue, et que les pirates se trouvaient plus a l'aise dans les lieux inhabités. A l'embouchure de la Seine, et particulièrement dans l'île ou presq'île de Jumièges, ou trouverait d'antres exemples de ces terminaisons en *hou*. Je me rappelle entr'autres celle de Koni-hou, qui, dans la langue du Nord, signifie miason du roi. Ce roi pouvait bien être un roi de mer, ou un capitaine de vaissean, ou tout simplement le nomme d'un homme qui s'appelait Le Roy."—*Pamphlet*, p. 14 and 15.

Mr. Metivier informs me that "As carly as the reigns of Robert and Wilhelm (William) Guettehou, or Jethou (the Chetel-hou in the cartulary of *Cerisium, Cerisy*) had an '*hospes*,' '*hospitem unum*,' of course, a 'hou' or house."

* A statement of the population at various periods is now given.

Statement of the numbers of inhabitants in Herm and Jethou; obtained from the census of 1851.

Years.	Herm. No. of persons.	Jethou. No. of persons.
1821	28	9
1831	177	14
1841	38	6
1851	46	3
1861		

The "adjacent islands" mentioned besides, as containing inhabitants, are "Le Marchant" and Serk (Great and Little)." Ecrehou Dir-ou-illes, Brecqhou, Lihou, Burhou, are not named, evidently because they contain no inhabitants in modern times.

43. The following passage, which is quoted from p. 525 of *Duncan's History of Guernsey,* and written by F. C. Lukis, Esq., of Guernsey, an accomplished geologist, naturalist, and antiquary, tends to prove (especially by the parts which I have caused to be printed in Italics) that the islet of Herm was once densely populated, though its whole population in 1851 was only 46 souls. He says:—"The common limpet (patella vulgata) is very abundant on the rocks, and appears to have been used as an article of food to a greater extent than at present. The quantity of shells exposed over the surface, or occasionally dug up, *shows the vast use of these by the early inhabitants,* and in some places they are found *at a distance from the cottages* and at a depth of many feet below the soil. Beds of limpet shells are not unfrequently cut through in the island of Herm, where it is difficult to account for their accumulation."

M. de Gerville (pamphlet p. 36) gives a copy of a charter "extracted from the Cartulary of Cherbourg, and the archivist has since communicated to me the original." (A copy appears in the MS. Appendix). There was, in short, in 1440 a convent of cordeliers established (or then existing) in the isle of Herm. But the cordeliers probably did not use much of so poor a food as limpets. It will be shown afterwards by reference to *Cæsar's Commentaries on the Gallic war,* that there is reason to believe all these islets may have been numerously inhabited, and by persons who would eat limpets, as others did at and before Cæsar's time. If so, the beds of limpet shells are not surprising—they are probably, *shell middings.*

In Cæsar's Book 3, Sec. 12 (quoted hereafter) we find that when the works of the Romans overawed *one town,* the inhabitants carried away all their effects in their numerous ships and betook themselves into *other nearest towns,* and so baffled him during great part of summer. It will be shown that these transactions took place at the Northern Channel Islands, *not* near Vannes.

Everything can be accounted for, if there has been, as I say there must have been—a general sinking. The losses of land on the west and south of Jersey, and at the Ecrehons and Dirouilles; the former existence of groups of houses, *i.e.* towns, and the existence of shell middings—where there are now scarcely either houses or inhabitants—can all be perfectly well understood, if we admit that there has been a *general sinking.* Other things, about to be stated, can also be well understood on the same principle.

Chapter IV.

Losses of land on the Norman coast, on the west and north-west of Coutances.

44. From *Tableaux Historiques de la civilisation à Jersey,* par John Patriarche Ahier (now deceased), 1852, p. 97, we learn as follows:—

"The Seigneurs of Mont Chaton near Regneville, possessed at the end of the river which passes by Coutances, for all time the fishery of this little river as far as Roqui, a rock well known which is now two leagues in the sea.* Conformably to their title they had fished for all time also in the sea, as far as that limit; but their administration commenced an action in 1789 founded on this, that their right of fishing could not extend beyond the river; and two months before the Revolution, they established before the Parliament of Rouen; first, that their title gave them the right of fishing as far as Roqui, the place where the river of Coutances discharged itself into the sea. Second, that since a long time, it is true *the sea had invaded the land bordering on this river,*† but that that had not destroyed their right of fishing the ancient bed of the river. Third, that otherwise there existed still all along the ancient shores *the trunks of willows visible in the water,* which thus settled the limit where the right of fishing could be exercised By these reasons the Seigneur of Chaton won his action, and the Parliament confirmed to him his right of fishing. This decree may be found in the Archives of France, the last volume of decrees of the Parliament of Rouen. Plees has so stated p. 10 of his "History of Jersey."

It is quite true that Plees gives a summary of the facts now stated about the fishery, at p. 11, in his *Account of the island of Jersey,* published in 1817.

45. Mr. Ahier informed the writer that only a few years ago a fisherman dredging for oysters near the international oyster boundary (a part of which is marked on the Chart), brought up the stump of tree with portions of the roots attached, which was identified as a plane tree. It was obtained about opposite the centre of Jersey, and therefore about four miles from the present French shore.

46. M. Lecanu who published his *Historie des Evêques de Coutances* at Coutances, in 1839; gives a preliminary chapter on the means, end, and method of his work, and mentions by their names his very many authorities.* Saying at p. 6:—"Such is the immense quantity of materials among which we have chosen, piece by piece, the elements of this history." And at p. 10, he says, "We have pruned off all which appeared to us disputable, all that which we have thought uncertain; and if now and then we have inserted doubtful statements, we have cautioned the reader. We have laid aside all that which appeared to us to have little interest; and as such all the writings and private charters, which have no value for antiquaries; a great number of very small facts, of guarantees about particular acts and dates. In fact of guarantees we have preserved only those which were useful to fix the chronology." After all this judicious sifting and selection, he informs us at p. 14, *without any caution,* as follows:—"A vast marsh called Chesey (Scissiacum), covered with forests, filled up all the space now occupied by the Ocean from the coast of Britanny as far as Cherbourg, or the Val de Saire, widening itself at the side of Chausey and Jersey over a depth now unknown." And at p. 21, speaking of the forest of Sciscy, he says:—"The dimensions of this marshy ground cannot now be defined; but this is what we know: in the first place we have assured ourselves that from S. Pair† to Cape la Hague there exist very numerous stumps of trees rooted in the clay of the shore."

47. It will now be convenient to continue the quotation from Mr. Poingdestre's MS., commencing at the point where we left off in Art. 32. He says: "Neither will I here mention another yet more fabulous tale of the coniunction of Jersey to Normandy by a bridge or without a bridge, which never was unlesse it were before the flood. It is very certain that above eleven hundred years agoe it was bestowed upon St. Sampson, Bishop of Dol, under the appellation of Island, and that it was in Antoninus his Itinerary called an Island, above two hundred yeares before that. But yet for all that, I dare say that whoever shall look with due reflexion upon y[e] most craggy Coast of St. Clement, at a low Ebbe, and then behold an infinite number of different rocks close one by another, will not be much out, for beleeving that soe many bones of mother Earth were not at first created naked; and consequently that the sea hath by degrees as long running worne and diluted that earth w[ch] was about them; leaving onely that part behind which it could not dissolve."

I agree with Mr. Poingdestre that the Banc du Viellet was "not at first created naked." And I agree also "that the sea hath by degrees as long running worne and diluted that w[ch] was about" the rocks. I say that the soil has been washed away since the ground sunk and brought it within reach of the tides. To the rest of his statement I partly object, and say that it requires farther explanation; and will now attempt to bring the matter correctly under the reader's consideration.

Ptolemy, the Geographer, gives reasons for believing that Jersey was part of the Continent in his time.

48. In pursuing this interesting investigation, it was obviously of great importance to ascertain whether the promontories, harbours, mouths of rivers, &c., of which Ptolemy gives (in his own way) the latitudes and longitudes; were or were not correctly laid down by him. Because those positions were clearly points in the ancient coast lines, and if he had laid

* It is $2\frac{1}{4}$ English miles by the sailing charts, and is called *Ranqué* on the English chart and *Ronquet* on the French chart.
† The italics are the present writer's

* The names are recited in the MS. Appendix.
† About two miles south of Granville.

them down correctly, we should at once have a vast amount of information bearing directly upon the present question. And, supposing him to be correct, we should know the situation of the coast as it existed in the first half of the second century, which was the time when he flourished. After considerable further research beyond what has hitherto been narrated; it became clear that such vast losses of land had occurred since his time on the northerly and westerly coasts of France, that it was doubtful whether any positions on the present coast of France could be identified as the places indicated by him. And ultimately the centre of the Isle of Wight (which he and other ancient writers call Vectis), and the Lizard Point (which he calls the Damnonian and Ocrinum promontory) were fixed upon as bases, or points of departure, in which there had probably been little or no alteration in longitude since his time, but there must have been alterations in latitude which have been allowed for, and are explained hereafter. He gives, in his own way, the latitudes and longitudes of these two points, and their modern latitudes and longitudes having been obtained from the British Ordnance survey, it was clear that his latitudes and longitudes could now all be reduced to modern, which was accordingly done, and the results will be given in a future chapter. Two important positions of his, on the north coast of Britanny, successfully stood this rigid test, namely, the Gobæum promontory of the Osismii; which is well known to be the north-eastern angle of Britanny, and Staliocanus Portus, which fell all but exactly where is now the small harbour of Portrieux. At the Gobæum promontory, the existence of stumps of trees and remains of buildings, bear witness to the fact of the land having extended somewhat farther north than it does at present. Allowing for which, Ptolemy's and the modern positions are very nearly identical. This ought to give us confidence in his approximate correctness on the north of Britanny. And accordingly his "Mouth of the river Argenis" and his "Mouth of the river Tetus" have been laid down upon the chart (as the reader will find), which of course was done by means of his latitudes and longitudes being reduced to modern. But there are farther corroborations of the correctness of his position of the mouth of the Argenis. Mr. Ahier affirms, at p. 98, that Mont S. Michel was once "dix lienes de l'Océan," which is nearly the distance from the Mont to the mouth of the Argenis. When asked for his authority for the statement, he could not remember. M. Bonissent, also, Membre de la Société Géologique de France, &c., in a pamphlet called "Essai Géologique sur le Departement de la Manche," published in 1860, speaks of Mount S. Michel being "en pleine forêt, à dix lieues de la mer." I have not been in communication with this gentleman, and consequently cannot give his authority for the statement. If the position of the mouth of the Argenis is right, the position of the mouth of the Tetus is not likely to be far wrong. By the former it will appear that France once extended farther west than it does at present by seventeen miles, and by the position of the latter that the land extended more than thirty miles farther west than it does now. There are other corroborative circumstances, presently to be detailed, tending to prove that Jersey was connected by dry land with the Continent since Ptolemy's time. Such being the case, there is no necessity to debate about the existence, or not, of the bridge mentioned by Mr. Poingdestre.

The Roman Itinerary, so called of Antoninus.

49. In the Itinerary; *Cæsarea* is Jersey, *Sarmia* Guernsey, and *Arica* Alderney; by common consent of commentators. This is the first mention of Jersey in History, and Mr. Poingdestre seeks to fix a date by means of the Itinerary, but that is plainly impossible—it was added to from time to time like Bradshaw's Railway Guide of the present day. The paragraph following contains a few facts gathered chiefly from Wesseling's Preface to the Itinerary, which contains a large mass of very valuable comments, on the authorship of the Itinerary, by about seventy learned men. The several dates I have added.

Alexander the Great, born 355 B.C. had his Βηματίσαι or measurers of his journeys. Some other materials for an Itinerary existed as early as Polybius's time, 124 B.C. Strabo, who died A.D. 25, Pomponius Mela who flourished about A.D. 45, and Pliny, the elder, who lived from A.D. 23 to 79 laboured very diligently in this business. Metius Pomposianus who lived A.D. 81-96, represented the whole world on parchment. Marinus, the Tyrian, and Ptolemy, the geographer, laboured hard in preparing materials that were suitable for an Itinerary. The Romans penetrated the whole of Britain in the first century after Christ and vacated it and Armorica (Britanny) A.D. 409.*

Now, it is certain that there could be no Roman roads in Britain before Cæsar's first invasion, B.C. 55, and that new Roman roads would be made in Britain from time to time and added to the Itinerary, until about Gibbon's date, namely, the beginning of the fifth century. The name of Constantinople occurs four times in the Itinerary, although that city was not inaugurated until A.D. 331, after having been six years in building.

Cæsarea, or Jersey, was therefore not necessarily inserted in the Itinerary until the fourth, or even the beginning of the fifth century; and there was consequently plenty of space of time for Jersey to have become an island between that date and Cæsar's invasion of Gaul, which happened more than half a century before the commencement of the Christian era. Indeed, in the two and a half centuries accruing between Ptolemy's time and the evacuation of Britain and Britanny by the Romans, the sinkings now under consideration may have occurred, and probably did occur. His positions of the mouths of the Argenis and Tetus would appear to justify us in believing so. Next month further reasons will be given for believing that Jersey was since Ptolemy's time an integral part of the Continent.

(*To be continued.*)

ARTIFICIAL GAS COAL.

While experimenters with petroleum as steam fuel, have been endeavouring to create a market for the heavy mineral oils, which is a serious obstacle to the profits of oil makers, Mr. George McKenzie, a Glasgow gentleman, has been conducting a series of experiments with a view to using this class of oil in the manufacture of gas. Mr. McKenzie, having had some experience as a gas engineer, conceived the idea of making the waste heaps, at the pits' mouths, a profitable material for gas making; and, knowing that others had attempted to make gas from oil alone, he set himself to work to discover how the two might be combined, so that one would supply the requisite properties which were deficient in the other. Firstly; it is an established fact, that any endeavour to make gas from mineral oil involves no small amount of waste, because a proportion of the vapours will invariably be reconverted into oil, upon coming into contact, accidentally or otherwise, with a cool surface. It is also well known, that the siftings —or coal gum, as it is called in Scotland—which lie as refuse in the neighbourhood of all pits, are not suitable for gas-making purposes. On the one hand, we have a material deficient in carbon; and on the other, another material very rich in this property. The two, combined in careful proportions, go to make a substance which, when distilled in an ordinary fireclay retort, gives results which are likely to prove of incalculable importance to both gas companies and crude oil manufactures. Mr. McKenzie grinds the coal "gum" to a fine powder, and then saturates it with the necessary proportion of crude petroleum or shale oil, and although the proportion is regulated according to the quality of the coal, still the variations are so slight, as to render the manipulation a matter of the greatest simplicity. This mixture is then distilled, and it appears that the yield is not only much greater than that from the best gas coal, but that there is no waste or recondensing of oil, and that a coke is left which, for certain special purposes of ironmasters, promises to be worth three or four times the value per ton of ordinary coke. We may here make a comparison, as it was explained to us by the patentee, the correctness of which, we have every reason to believe, has been amply proved by experiments on a commercial scale. At the present prices of material the mixture of coal and oil will cost about twenty shillings per ton. One ton will give 16,000 cubic feet of gas, equal in illuminating power to 32 sperm candles. On the other side, the cost of Lesmahago gas-coal is at present about thirty shillings per ton. It yields about 9,000 cubic feet of gas. The coke from the Lesmahago coal is sold at five shillings per ton. It is considered by some competent judges that the coke from Mr. McKenzie's mixture is worth about twenty shillings per ton for ironmasters' purposes. A number of retorts at the Johnstone Gas Works—a populous village about twelve miles from Glasgow—were placed at the

* See Gibbon, Vol. 5, p. 346, who quotes Zosimus.

disposal of the patentee for the purposes of experiment, a separate holder was set apart to contain the gas, and on several nights the entire town was illuminated with the new gas. In addition to this, we are told that a quantity of gas was left for eight days in the holder, at the end of which time, it was found that it had not lost anything in bulk by condensation, the only perceptible change being the expansion, to the extent of about three inches during the day, and a corresponding contraction during the night. The durability of the gas burnt at Johnstone is spoken of very favourably; for it appears that one cubic foot, burnt by a four-wick flame, will last 78 minutes. It would thus seem that in every respect the new process effects a great saving. Applied to the manufacture of oil, at a low red heat, we are told that the addition of a certain proportion of crude oil to the shale assists the passing off of the vapours, and that the addition of thirty gallons of oil to a ton of ordinary Scotch shale will cause it to yield eighty gallons of oil. We are not prepared to say how far this may be true in commercial practice, but the idea is worthy of consideration. Mr. McKenzie is about to visit London, with the object, we believe of introducing his discovery to some of the London gas companies. City people have complained long and loudly of the quality and cost of their gas; perhaps they may find a remedy for their grievances in Mr. McKenzie's process.—*The Oil Trade Review.*

ON PRODUCING AN INDEFINITELY LARGE AMOUNT OF DYNAMIC ELECTRICITY.

Some few years since, our electricians devoted much valuable time to an endeavour to obtain motive power, economically, by means of galvanism or magnetism. All their ingenious contrivances proved to be abortive. Dr. Faraday threw a damper on their efforts, by showing the expenditure for creating this power to be too great for commercial purposes. He did so in accordance with the then existing knowledge of the subject. The esteemed and venerated doctor had, at that time, done much to develope and apply galvanism, magnetism, and electricity; he was not satisfied with what he had done, when there remained so much more to be done, and his vast experience qualified him for a pioneer. It remains for others to rightly apply his discoveries, and as in the instance before us, we may progress to the development of this interesting branch of science, to valuable results, with his facts for our guide. Our esteemed scientific contemporary, the *Chemical News*, contains a paper by H. Wilde, Esq., p 245-6, recording some facts, which may become highly important in our commercial economy. An extract will be sufficient for our present purpose:—

"The author directs attention to some new, and paradoxical phenomena arising out of Faraday's important discovery of magneto-electric induction, the close consideration of which, has resulted in the discovery of a means of producing dynamic electricity in quantities unattainable by any apparatus hitherto constructed. He has found that an indefinitely small amount of magnetism, or of dynamic electricity, is capable of inducing an indefinitely large amount of magnetism; and, again, that an indefinitely small amount of dynamic electricity, or of magnetism, is capable of evolving an indefinitely large amount of dynamic electricity.

"The apparatus with which the experiments were made, consisted of a compound hollow cylinder of brass and iron, termed by the author a magnet-cylinder, the internal diameter of which was 1⅝in.. On this cylinder could be placed, at pleasure, one or more permanent horse-shoe magnets. Each of these permanent magnets weighed about 1lb., and would sustain a weight of 10lbs. An armature was made to revolve rapidly in the interior of the cylinder, in close proximity to its sides without touching. Around this armature 163ft. of insulated copper wire was coiled, 0·03 of inch in diameter, and the free ends of the wire were connected with a commutator fixed upon the armature axis, for the purpose of taking the alternating waves of electricity from the machine in one direction only. The direct current of electricity was then transmitted through the coils of a tangent galvanometer; and as each additional magnet was placed upon the magnet-cylinder, it was found that the quantity of electricity, generated in the coils of the armature. was very nearly in direct proportion to the number of magnets on the cylinder.

"Experiments were then made for the purpose of ascertaining what relation existed between the sustaining power of the permanent magnets on the magnet cylinder, and that of an electro-magnet excited by the electricity derived from the armature.

"When four permanent magnets, capable of sustaining collectively, a weight of 40lbs., were placed upon the cylinder, and when the sub-magnet was placed in metallic contact with the poles of the electro-magnet, a weight of 178lbs. was required to separate them. With a large electro-magnet, a weight of no less than 1,080lbs. was required to overcome the attractive force of the electro-magnet, or twenty-seven times the weight which the four permanent magnets used in exciting it, were collectively able to sustain. It was further found that this great difference between the power of a permanent magnet, and that of an electro-magnet excited through its agency, might be *indefinitely increased.*"

Here is the power with economy which our scientific men have long sought for, but hitherto in vain. The current expense must be for simple wear and tear of appparatus; no coals, no water, no danger, no boiler required. It will be all but a perpetual motion, with useful power. The collective weight of the permanent magnets, we see, was but 4lbs., and the power produced was 178lbs. The electro-magnet was but 1⅝in. internal diameter, and when this toy was exchanged for one larger, the size is not mentioned, we see the available power rises to 1,080lbs., with the same magnets. Experience can teach us how long the magnets will retain their magnetic power, when subject to this treatment; but relays are not impracticable nor is "retouching" them an impossibility, for a child might do either or both.

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

The twenty-eighth half-yearly meeting of the members of this society took place on the 7th ult., at their rooms, Doctors' Commons, City. The chair was occupied by Mr. Joseph Newton, of H.M. Mint, president, and the audience was very numerous. After the reception of the minutes of the previous meeting the election of several new members was proceeded with, and then came the report of the auditors. This document revealed a very satisfactory and indeed prosperous state of affairs. The receipts were shown to have far exceeded the expenditure of the society, whilst the demands made upon the funds for the assistance of unemployed members were very small in amount. Without entering into the details of the balance-sheet for the half-year, a copy of which lies before us, it may not be improper to give the following financial summaries, viz.:—

GENERAL FUNDS OF THE SOCIETY.

	£	s.	d.
Cash in Treasurer's hands, June 30th, 1866	50	0	11½
Do. in Savings' Bank	30	0	0
Stock in 3 per Cent. Consols	400	0	0
	£480	0	21½

SUPERANNUATION FUND.

	£	s.	d.
Stock in 3 per Cent. Consols	676	13	0
Interest on do.	18	1	9
	£694	14	9

It will thus be seen that the total amount of money available for all purposes invested, or held by the committee of the association, is something over £1,100. It was stated that although no decayed foreman—for the benefit of which class the superannuation fund was originally instituted—had as yet claimed a superannuation allowance, it was desirable that, in order to be eventually useful, the fund should be largely augumented. By a rule of the society it is arranged that only the interest upon the gross sum subscribed can be employed for superannuities. It was hoped, therefore, that other engineeering employers would follow the generous example of those who had already contributed, and thus establish efficient resources for the relief of their worn-out and necessitous foremen.

Some discussion on various items of the balance-sheet followed, and the secretary, Mr. David Walker, entered into an elaborate exposition of the growing influence and increasing usefulness of the society. These effects he maintained were due to the altered and far more favourable attitude assumed towards the associated foremen by their employers, the publicity given to the society's proceedings by the scientific press, and the unremitting labours of their president. The number of members, honorary ond ordinary, at present on the books of the association amounted to 150, and this was being added to at the rate of about 30 per annum. The report of the auditors (Messrs. Oubridge and Grint) was then unanimously adopted. The election of Messrs. Haughton, White, and Watts as committee-men, in place of three others retiring by rotation, brought the business proceedings of the evening to a close.

In obedience to the request of the chairman, Mr. A. Laird next read a paper on "Slide Valve Improvements." This was partly historical, and partly anticipatory, and the author certainly dealt with his subject in a lucid and practical manner. He adverted to the importance of the slide-valve, in an economical and in a scientific sense, and showed that in some respects its arrangement and action were still defective. The lateness of the hour (nearly 11 p.m.) when Mr. Laird concluded his paper prevented any discussion of its merits on Saturday, and this therefore stands over until the next meeting of the society, in August.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

"During the last month 253 engines have been examined, and 388 boilers as well as five of the latter were tested by hydraulic pressure. Of the boiler examinations, 260 have been external, 7 internal, and 121 entire. In the boilers examined, 83 defects have been discovered, 10 of those being dangerous, thus:—Furnaces out of shape, 3; fractures 6 (2 dangerous); blistered plates, 8; internal corrosion, 6; external corrosion, 11 (5 dangerous); internal grooving, 3; feed apparatus out of order, 2 (1 dangerous); water gauges ditto, 3; blow-out apparatus ditto, 6 (1 dangerous); safety valves ditto, 5; pressure gauges ditto, 8; without feed back-pressure valves, 21; case of deficiency of water, 1.

"Both the cases of fracture, mentioned among the daugerous defects in the preceding list, occurred at the bottom of externally-fired boilers, and at the ring seams of rivets over the fire. Four of the cases of external corrosion were found in 'wagon' boilers, and at the bottom of the side pockets where they rest upon the brickwork seating, the corrosion exteuding longitudiually for a considerable distance, and in some places reducing the thickness of the plates to one-sixteenth of an inch. Another instance of external corrosion was met with at the bottom of a 'Cornish' boiler, round the joint of the blow-out pipe. The cross walls at this part are apt to be too thick, and to promote, while they conceal the wasting of the plates. They should be recessed, so that the whole of the blow-out pipe may be in front of the wall, instead of any part of it being buried in the brickwork, as it is too frequently found to be. The blow-out tap referred to, could not be closed after testing, on account of the box key running round on the head of the plug, through the dilapidated state into which it had been allowed to fall, so that the boiler was drained of its water, the furnace crowns laid bare, and brought up to a red heat before the fires could be drawn.

Explosions.

"On the present occasion I have a long list of explosions to report, teu having occurred during the past month, by which six persons have been killed, and ten others injured; while two other explosions, which occurred in previous months, have just been reported to me, the first of which happened on the 22nd of March, and the second on the 13th of May. These will now rank in the tabular statement for the year as No. 15a and 21a. Not one of the boilers in question was under the charge of this Association.

Tabular Statement of Explosions, from May 26th, 1866, to June 22nd, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
23	May 26	Single flue, or "Cornish." Internally-fired	1	0	1
24	May 27	Plain Cylindrical Egg-ended. Externally-fired	1	0	1
25	May 27	Plain Cylindrical Egg-ended. Externally-fired	1	1	2
26	May 28	Single-flue, or "Cornish." Iuternally-fired	1	3	4
27	May 31	Plain Cylindrical Camber-ended. Externally-fired.	1	1	2
28	June 7	Marine Vertical. Internally-fired	0	0	0
29	June 11	Particulars not yet fully ascertained..................	0	2	2
30	June 11	Single-flue, or "Cornish." Internally-fired	1	0	1
31	June 14	Single-flue, or "Cornish." Internally-fired	0	0	0
32	June 19	Locomotive......................	0	3	3
		Total..................	6	10	16

"No. 23 explosion, by which the fireman was scalded to death, took place at about six o'clock on the morning of Saturday, May 26th, at a paper mill.

"The boiler, which was not under the inspection of this Association, was of the Cornish class, being internally-fired, and having a single furnace-tube running throughout. The length of the shell was 24 fect 6 inches, and the diameter 5 feet; while the internal tube, which was oval at the furnace end, for a length of 6 feet, measured 2 feet 9 inches vertically, by 2 feet 7½ inches horizontally, the remainder being circular and 2 feet in diameter, while the thickness of metal was about seven-sixteenth of an inch, and the load upon the safety-valve 50lb.

"The boiler failed at the furnace tube, which collapsed at the crown, immediately over the fire, the second and third plates from the front, as well as a portion of the fourth coming down, while the third rent through the middle transversely, for nearly half the circumference of the tube, and it was from this rent that the water and steam escaped which scalded the fireman to death.

"The failure of the furnace crowu was attributed, at the inquest, to overheating of the plates, through shortness of water, while this view is confirmed by a competent engineer in possession of the facts, who has kindly favoured me with a report upon the explosion, and although I am unable to corroborate this from actual observation, not having visited the sceue of the explosion, yet it seems to me to be correct; and that the particulars already given of the proportions of the internal tube, coupled with the position and direction of the collapse, tend to strengthen this conclusion.

"It is worthy of remark, that on the occurrence of the explosion, the boiler was not blown to a distance, neither was the building in which it stood brought to the ground, as is too frequeutly the case, but the whole remained intact, the boiler not being disturbed an iuch from its seat, so that a man standing upon it, at the very moment, escaped uniujured. This immuuity from destruction in the event of explosion is peculiar to the collapse of the furnace-tubes of internally-fired boilers, and contrasts favourably with the result of those fired externally, as will be seen in the report of the explosions given below. In the event, however, of the failure of the cylindrical portion of the shell of an internally-fired boiler, the result may be as destructive as in that of one fired externally, though the latter proves to be of much more frequent occurrence than the former, while it cannot be as surely prevented by periodical inspection. The results of the present explosiou are by no means siugular, and similar cases have been given in the Associatiou's report, from time to time, in which, though collapse of the furnace-tube has occurred, neither the boiler itself, nor those adjoining it, have been stirred from their seats, nor the steam pipe joints broken, so that it has only been necessary to screw down the junction valve in order to work the engine on just as before. The injury that results in case of collapse, is generally limited to that done by the rush of water and steam from the rent, and is iu a straight line from the furnace mouth, so that, if the firing space be open, persons, though near the boiler at the moment of explosion, may escape unhurt, if only on one side of the furnace mouth; but if the firing space be confined, then those near would be scalded by the steam and hot water.

"Explosions Nos. 24 and 25 are so similar that they may be treated together. They happened on Sunday, May 27th, 1866, the one at half-past six in the morning, and the other at six in the afternoon, both of them occurring at collieries to plain cylindrical externally-fired boilers, the uncertainty and danger of which it has been found necessary so frequently to point out in previous reports. Neither of the boilers was under the charge of this Association.

"In each case a good deal of damage was done. Both boilers were thrown from their seats, and the engine-houses which adjoined brought down, the beam of one of the engines being broken, and masses of brick and stonework scattered in all directions, some of the bricks falling upon aud breaking throngh the roofs of pitmen's cottages fifty yards off. In the case of the first explosion, the fireman was scalded to death and buried in the ruius; and in the other, the attendant was thrown to a distance and seriously injured, while a child in the arms of its mother, who was standing at her own door, was killed on the spot by a blow on the head from a brick, or other portiou of the *debris* scattered by the explosion.

"The first boiler was 32 feet long by 6 feet in diameter, and the secoud, 34 feet 6 inches by 5 feet, the thickness of the plates being three-eighths of an inch in both, and the load on the safety valves 35lb. per sqnare inch in the one case and 45lb. in the other; so that the pressure of steam was not excessive for the diameter of the boilers, while they appear to have had an ample supply of water at the time of the explosion. Boilers of the externally-fired class do not generally explode from excessive pressure or shortness of water, but from failure of the seams of rivets at the bottom of the shell, and more especially of those immediately over the fire. Such was the case in the present instance. Both of these boilers had giveu way at the bottom, and had to be repaired. In one, four new plates had been put in just over the fire about a fortnight before the explosion, and in the other, repairs has been effected three times within the last few months, and but nine days before the explosion occurred, seventy rivets taken out, forty of which were loose. This boiler was fed with water drawn from the pit, which was of a very sedimentary character; while, in addition, the fireman was iu the habit of feeding the boiler with meal in order to keep it tight, and had gone away to get a supply to stop a leak that had just sprung from the seams of rivets over the fire, when the boiler exploded.

"At the coroner's inquests, the explosion of the latter boiler was attributed to the sediment, and this doubtless had much to do with it, though it would not have had the same effect upon the boiler had it been interually-fired, since much of the sediment would then have fallen to the bottom beneath the furnace tube, instead of depositing in a mass on the plates over the fire. The other explosion was considered to be altogether unaccountable. The superintending engineer to the colliery, who had held his position for sixteen years, said he could form uo opinion whatever as to the cause of the explosion, while both the eugineman and smith thought the boiler was quite safe, the latter haviug put in the four new plates previously referred to hut a few weeks before it burst, aud haviug at the same time minutely examined it and found all right, otherwise he would have extended the repairs still further. Iu consequence of this evidence the jury stated in the verdict that 'there was nothing to show the cause of the explosion,' so that no information was disseminated by the corouer's inquiry that would tend to prevent the recurrence of similar catastrophes.

"These two explosions are simply illustrations of the dauger of plain egg-ended externally-fired boilers, especially when fed with sedimentary water, their treacherous character being clearly shown by the fact, that both of those under

consideration exploded so shortly after they were repaired, while one of them had been laid off for cleaning and examination, and passed as safe but the day before it burst."

THE "MIANTONOMOH."

Such is the name given to a transatlantic novelty of 1,500 tons burthen. It is a vessel of war, "with all the latest improvements." She is designed to be offensive, in the completest sense of the word. To this end she carries four 15-in. guns, which can throw a shot of 450lbs. weight. These monster guns are ensconced in turrets that are protected, not by junks of iron, bolted to a wood "backing," but by ten series of iron plates, each plate planed to a gauge of an inch. These are "built" up in a workmanlike manner, with their butts, or joints, properly shifted. They form a series of hoops. These plates are fastened with conical bolts, with their nuts on the inside, so that however gouged by the flat-headed shot-bolts, the tapering bolt still holds what remains, in its proper place. Her commander has fired a total of 750 rounds, from one of these guns; the greatest number, in any one day, was sixty rounds. The turrets are 21ft. in their interior diameter; their height from the floor to the over-head beams is 6ft. 4in. Their total height above the deck is about 9ft. The deck is of 3-in. iron, covered with 3in. of wood, which rises above the base of the turret. The turret sits on a planed surface of mixed metal, having a corresponding ring of metal, planed, to slide on the other when in motion, each properly secured, the one to the turret and the other to the deck. But the turret can be raised by a central spindle, and thus reduce the friction at least two-thirds. The top of the turret is closed in with massive iron bars, 4in. by 3in., which are covered with iron plates 1in. thick, and perforated for ventilation. The two gun-ports are each 2ft. wide by 3ft. 10in. deep. The port is closed, after discharging a gun, by a 13-in. iron "stopper," pivoted at the floor and at the roof of the turret, and swings easily into or out of position. The pilot-house is on the top of each turret, which may weigh altogether some thirty tons. The immense gun is so evenly balanced that it can be "elevated" with a $4\frac{1}{2}$-in. screw, by the finger of a man's hand. The carriage, also, is of superior construction, and its simplicity is, as usual, an index of its strength. The compressors are three iron plates, working between four balks of wood. The slide is on a level with the turret floor, and is made of two iron beams, 9in. by 3in., planed on their upper face, and properly secured. Two men can run the gun in or out with ease, and one man can regulate the compressors. The "sights" give a range of 2,300 yards. The gun can be elevated 9°, and depressed $3\frac{1}{2}$°.

The turrets derive an elasticity from their hoop-like mode of construction, devoid of wooden backing. The conical bolts retain their hold on every plate in succession. The damage of a shot is thus limited to its gouging ability.

The propelling engines—for there are no less than seventeen, to be worked as required, on board are of 800 nominal horse-power, "on the back-action principle of Mr. Isherwood." The connecting rod works towards the cylinder. The cylinders are 30in. diameter, with a stroke of 27in. The engines make 80 revolutions, with 35lbs. to 38lbs. of steam. The twin screws revolve inwards, or towards each other. The average temperature in the engine room, on the voyage, was 80°, in the stokehole 120°, and in the captain's cabin 75°. The average speed of the vessel is reported to be eight knots.

The hull shows some 18in. above the surface of the water; the sides are several feet thick, and amply protected by wrought iron, so that there is left only the well-protected turrets exposed to attack. The officers profess to be well content with their ship. In point of fact, with a competent navigator or two, the officers and crew might be select artillerymen, if we except the duties incumbent on the engineers. At sea they are all below, as in a diving bell, excepting the officers navigating in "the upper storey" of the turret. No less than six steam engines are employed forcing air through tubes into every part of the ship. It is brought down a pipe, which extends some 9ft. above the deck. In harbour this is not necessary when sundry scuttles can be opened without danger of sinking the ship. We hear of the *Miantonomoh* having taken a short trip to Cherbourg, and will thence return to the Thames, accompanied by two men-of-war, to act as nurses whenever required.

The *Miantonomoh* derives the name from a celebrated red Indian chief, who distinguished himself in some of the old wars.

SAFETY GATES FOR THE LEVEL CROSSINGS OF RAILWAYS.

There is now exhibiting in the centre transept of the Crystal Palace, a working model of an invention for preventing those accidents which are of such frequent occurrence on the level crossings of railways. It is the invention of Mr. George Daws, and may be described as follows:—For foot passengers Mr. Daws uses the turnstile instead of the common swing gate. The arms of this turnstile reaching to within a few inches of the ground; and for carts, carriages, &c., two pairs of gates are used.

These stiles and gates, supposing the line to be free from trains within a stated distance, can be opened for the admission of passengers, carts, &c.; in the instance of the cart-gates the gatekeeper has only to push one gate, when all open simultaneously. Then after the carriage or cart has passed over, by his leaving the gate, all close of themselves, thereby preventing them being left across the lines through carelessness or otherwise, and leaving the way clear for any train that may be approaching; this being done without the aid of springs. At a distance of three or four hundred yards from the gates a treddle is fixed to the side of one of the metals, and is connected by means of a wire to the locking action beneath the gates. Upon a train approaching, the wheel of the train pressing down the treddle locks all the gates and stiles, thereby preventing admission on to the line, but at the same time leaving the stiles free to turn outwards so that any person who may be crossing at the time, can pass off.

One of the principal features in this invention is, that the works are so supported and connected that it would be almost impossible for them to get out of order, either through the action of the atmosphere or constant working.

It is an awful fact that no less than eight lives have been already sacrificed in this year, three of which took place in the present month, by not having any better protection than the common swing gate.

This invention is certainly deserving of the utmost possible attention on the part of railway companies, indeed it is only second to the use of the most complete system of station, distance, and train signals, in connection with the points and crossings of which, by the bye, the only ones worthy of entire reliance are those of Messrs. Saxby and Farmer, of Kilburn, which we are glad to see are now being so extensively introduced.

THE NEEDLE GUN.

The European continent has become an immense battle field. Armies of hundreds of thousands of men have been marshalled by the tact of experienced generals, and led to battle by skilful officers of all grades in the service. The robust men who composed the rank and file, were well drilled to duty, and there rests not the shadow of a shade on their courage, nor on their ability.

Politicians of all grades and sections, shuddered when contemplating what promised to be a long, a bloody meeting, or succession of conflicts between these immense contending armies.

This fierce struggle, though now somewhat abated, has resulted in the space of fewer days, in the sacrifice of more life, and in the capture of more thousands of prisoners, than the best informed could have imagined. History records no parallel. Austrian generals never before were so humiliated, in the utter worthlessnes of their plans of operations. There must be some cause for this surprise, this sudden discomfiture of the strong.

Some few years ago *a mechanic*, in or near Berlin, made a practical needle gun. This gun was tried, proved, and adopted by the Prussian army. Now we all see its wonderful effects. People talk loudly of "the needle gun," and we may presume to attach proper importance to the *mechanic* who is the originator of it,* who has thus proved *himself* capable of humiliating the ablest generals, scientific officers, and the hundreds of thousands of brave men, of one of the most skilful military empires in the world.

The Prussians, we are told, advanced, three deep, as is their custom, to within 150 paces of the enemy, then they fired, and repeated that deadly aim *so quickly*, that the front of the enemy became a heap of slain, over which the remainder stumbled into confusion. The Austrians intended to finish, as usual, with the bayonet, at the use of which they are accredited to be superior to the Prussians, but, the deadly needle gun quickly deprived them of the opportunity, and of the honour of victory. We unhesitatingly put in a claim on that honour, for the mechanic, the author of the needle gun.

We purpose reverting to the important subject of the needle gun in our next.

INCRUSTATION OF BOILERS.

A very interesting report by Prof. Chandler of the School of Mines, New York, "On the water used for locomotives on the New York Central Railroad and on Boiler Incrustations," was published lately by the *Journal of the Franklin Institute for the State of Pennsylvania.* The report contains carefully elaborated analyses of waters from seventeen different sources, and the summary of this part is made in an excellently arranged table. (See Table I., page 184).

* Herr Von Dreyse (for he has been enobled by his sovereign) was a percussion-cap and gun maker, of Sömmerda in Prussia. He is the inventer of the neede gun, which he originated in 1830. He also invented the peculiar cartridge, used in this gun, to which the Prussian officers attach much importance for completing the superiority of the weapon. Other compositions for ignition, say they, have been found to ignite too quickly, or the reverse, and some lose their efficiency after a certain period. The Prussian Government has made every effort to keep the secret of this composition.

TABLE I.—COMPOSITION OF WATERS NOW SUPPLIED TO LOCOMOTIVES.

Stations.	Corroding Constituents.						Incrusting Constituents.						Incrustation Preventives.		Organic Matter.	Total.
	Chloride of Potassium.	Chloride of Sodium.	Chloride of Magnesium.	Sulphate of Potassa.	Sulphate of Soda.	Sum.	Sulphate of Lime.	Carbonate of Lime.	Carbonate of Magnesia.	Oxide of Iron.	Silica.	Sum.	Carbonate of Potassa.	Carbonate of Soda.		
Syracuse, Onondago Creek ...	0·32	2·14			0·98	3·44	10·68	7·25	4·31	0·06	0·28	22·58			0·34	26·36
„ Hydrant	0·24			0·07	0·07	0·38	16·71	6·84	3·69	0·06	0·25	27·55			tracc	27·93
Warner's	1·91			1·81		3·72		7·17	3·63	0·11	0·37	11·28	2·17	6·09	0·37	23·63
Memphis	0·29	0·26			0·36	0·91	10·12	6·75	4·41	0·09	0·31	21·68			0·18	22·77
Jordan	0·33	0·76			0·62	1·71	4·02	5·03	2·30	0·03	0·09	11·47			0·06	13·24
Port Byron	0·39			0·32	0·37	1·08	0·01	5·43	1·57	trace	0·16	7·17			1·28	9·53
Savannah	0·59			0·07	0·69	1·35		11·93	5·04	0·10	0·56	17·63			1·52	20·50
Clyde, Spring...	0·14			0·18	0·45	0·77		9·66	4·40	trace	0·58	14·64			2·16	17·58
„ River	0·52	0·37			0·21	2·10	4·40	6·07	3·03	trace	0·80	14·30			1·88	18·28
Lyons	0·29			0·03	0·71	1·03	3·17	4·38	3·34	trace	0·18	11·07			1·00	13·10
Newark	0·47	0·38			0·32	1·17	3·19	9·15	6·01	0·08	0·30	18·73			2·16	22·07
Palmyra	0·76				0·67	1·43	18·81	8·41	5·98	0·02	0·17	33·39			1·46	36·28
Macedon Swamp	0·14			0.18	0·39	0·71	0·14	7·68	2·23	trace	0·48	10·53			0·80	12·04
Fairport	0·34	0·69	2·16			3·19	8·72	5·07	1·03	0·04	0·20	15·06			1·14	19·39
Rochester, North Street Well	0·96	4·82	1·53			7·31	6·46	16·92	8·88	0·10	0·90	33·26			1·60	42·17
„ Genesee River ...	0·28	0·05			0·85	1·18	3·16	4·64	2·06	0 09	0·90	10·85			1·64	13·67
„ Canal, Round House	0·33	0·17			0·61	1·11	2·16	4·60	1·81	0·05	0·18	8·80			1·24	11·15
Average	0·49	0·57	0·22	0·16	0·49	1·93	5·39	7·47	3·75	0·05	0·39	17·05	0·13	0·36	1·10	20·57

The numbers represent grains per gallon of 231 cubic inches.

This part of the report is followed by a very interesting analysis of the incrustations, of which Table II is the summary:

TABLE II.—ANALYSES OF BOILER INCRUSTATIONS.§

Source.	Structure.	Thickness.	Sulphate of Lime.	Carbonate of Lime.	Basic Carbonate of Magnesia.	Oxide of Iron and Alumina.	Water.	Organic Matter.	Silica.	Total.	—
1. Stationary engine, boiler shop. Syracuse: hydrant water	Compact and crystalline	$\frac{3}{16}$ths inch.	74·07	14·78	9·19	0·08	1·14	undet.	0·65	99·91	Fair average representatives of the usual incrustations.
2. * Stationary engine, machine shop. Rochester: canal water 10 mos., well water 2 mos..................................	„	2 inches.	71·37			26·87‖			1·76	100·00	
3. Locomotive No. 211. Freight, both roads. Syracuse..........................	„	$\frac{1}{32}$nd inch.	62·86	12·62	18·95	0·92	1·28	undet.	2·60	99·23	
4. Locomotive: surrounding brace.........	„	$\frac{1}{4}$th to $\frac{1}{3}$rd in.	53·05			42·16‖			4·79	100·00	
5. Locomotive No. 127. Freight, both roads. Syracuse	„	$\frac{1}{32}$nd inch.	46·83			47·85‖			5·32	100·00	
6. Locomotive No. 202. Freight, both roads. Syracuse	„	$\frac{1}{4}$th inch.	30·80	26·93	31·17	1·08	2·44	undet.	7·75	100·17	
Average	... ...	... ...	56·49	18·11	19·77	0·69	1·62	undet.	3·81	... ...	... ...
7. † Stationary engine. Niagara Falls: river water	Friable and granular.	2 inches.	4·95	86·25	2·61	1·03	0·63	undet.	2·07	97·54	Exceptional incrustations, the only ones of their kind.
8. ‡ Stationary engine. Townsend's Furnace, Albany	„	$1\frac{1}{4}$ inch.	0·88	93·10	2·84¶	0·36	0·15	1·96	0·62	100.00	
9. Locomotive No. 122. Rochester to Buffalo	Powder.		4·81			92·27‖			2·92	100·00	
10. Stationary engine. Barhydt & Greenhalgh, Schenectady	„		30·07			61·69‖			8·24	100·00	

* A mass weighing 21 ounces, which had apparently filled the space between three tubes.

† A mass weighing 14 ounces, evidently detached from a tube.

‡ „ „ 16 „ „ „ „

§ For method of Analysis, see Appendix.

‖ This number includes those belonging to the two preceding and the two following columns, as obtained by difference.

And the incrustations are classified as follows:

1. Hard, compact, and crystalline, formed of numerous thin layers, and consisting of from 30 to 75 per cent. of sulphate of lime, associated with carbonate of lime, basic carbonate of magnesia (2 Mg O, C O_2,) etc. (Analyses 1 to 6).

With a single exception all the locomotive incrustations were of this character, as were also most of those from stationary boilers. The incrustations from marine boilers belong to this class; they consist almost entirely of sulphate of lime.

2. Loose and friable, not at all crystalline; in thick masses, not in well defined layers, composed chiefly of carbonate of lime (Analyses 7 and 8). Only two specimens of this variety were met with, both from stationary boilers. They are evidently deposited from water containing very little sulphate of lime.

3. Consisting of a fine powder or mud. Noticed in only two instances; in one case in a locomotive, in the other in a stationary boiler. In composition the two specimens differ; one consisting chiefly of carbonate of lime and magnesia, the other containing 30 per cent. of sulphate of lime (Analyses 9 and 10).

A dissertation on the formation of incrustations and the various methods of prevention follows, in reference to which the following analysis of water from boilers using different methods of prevention is interesting, but would be much more so had an experiment been instituted using the same water in each boiler.

	1. No. 101.	2. No. 106.	3. No. 113.	4. Stationary, Machine shop, Syracuse.
Distance run	700 miles.	416 miles.	416 miles.	
Road	direct.	Auburn.	Auburn.	
Preventative used .	bran.	bran, 2 buckets.	nothing.	potatoes, one peck.
Reaction	neutral.	neutral.	neutral.	alkaline.
Sulphate of lime ...	17·88 grs.*	9·53 grs.*	39·89 grs.	49·82 grs.*
Carbonates of lime and magnesia ...	trace.	trace.	trace.	trace.
Chlorides, &c.	56·76 grs.	19·38 grs.	52·95 grs.	37·42 grs.
Organic matter ...	9·33 „	8·86 „	13·99 „	12·59 „
Nitrates	trace.		trace.	faint trace.
Total, per gallon ...	83·97 grs.	37·77 grs.	106·83 grs.	99·83 grs.

The following are the practical conclusions of the report:

"In conclusion, I would advise—

1. The use of the purest waters that can be obtained; rain water, wherever possible.
2. Frequent use of the blow-off cock.
3. That the boilers never be emptied while there is fire enough to harden the deposits.
4. Frequent washing out.
5. Experiments on the efficacity of zinc, lime water, carbonate of soda, carbonate of baryta, chloride of ammonium, some substance containing tannic acid, linseed meal, and the electro-magnetic inductor."

* These figures are probably too high, as they are calculated from the sulphuric acid a portion of which probably exists in the form of alkaline sulphates.

ON THE STEAM AND EXHAUST PORTS OF STEAM CYLINDERS.—THE PRACTICABILITY OF A MATERIAL REDUCTION IN THEIR DIMENSIONS SUGGESTED.

By D. M. GREENE, U.S. Naval Engineer.

(From the Journal of the Franklin Institute.)

The rules employed by designers of steam machinery in determining the areas of steam ports and passages, seem to be generally, if not always, entirely arbitrary; indeed, the "rule of thumb" appears to be not only the principal one used, but to find advocates in quarters and under circumstances where they would be least expected. The ever-varying conditions of steam pressure and velocity of piston appear to be ignored, and the unwarrantable assumption made, that the relation between the areas of the ports and passages and of the piston once determined, for an engine working under a given steam pressure, and with a given velocity of piston, furnishes a reliable precedent in designing all engines whatever may be the conditions under which they are to perform their functions.

In engines of great power, having large cylinders, and using steam of more than ordinary high pressure, great difficulty has been experienced in securing a proper action of the valves. This has been owing to the excessive weight of the valve, together with the enormous steam pressure upon its back, causing a rapid destruction of its face by friction. Much ingenuity has been expended in providing remedies for this evil, and as the results we have, among other contrivances, the "vacuum ring," the "Wadell plate," and the steel roller, all of which possess merit; but which, while affording partial relief, are objectionable on account of the difficulty attending their proper fitting up and adjustment, and especially on account of their liability to derangement after having been once adjusted.

It seems strange that, while so much has been done to mitigate the effect of the evil of large and heavy valves, nothing appears to have been done to reduce the evil itself to its minimum practicable proportions. Why has not some one suggested that the ports and consequently the valves, as now proportioned, may be twice or even thee times as large as necessity requires?

The writer, in constructing a formula for his own use in determining the proper areas of opening for steam ports, has had his attention forcibly directed to this matter by the result obtained; and, feeling that the subject is one of profound interest to the profession, will now indicate the course pursued by him in its examination.

Steam passes from the steam chest to the cylinder by virtue of an excess of pressure in the former over that in the latter. What this excess of pressure is, however, in practice, we are without reliable information; no experiments, to our knowledge, having been made with a view to determine it.

Indeed, such information is not essential; as we may assume any admissible excess of pressure, and base our determination upon such assumption. We will, therefore, assume 0·3 of a pound as an excess which is not only entirely admissible, but even considerably less than may be allowed in practice. This assumption being made, the velocity with which the steam will enter the cylinder through the port will be that due to the height of a column of the entering steam, the weight of which is equal to the assumed excess of pressure; in other words, the velocity of the current will be that which a body would acquire, in falling freely through the height of a column of the entering steam, having a base of one square inch, and weighing 0·3 of a pound. The volume of steam admitted through the port will depend upon the area of the port and upon the velocity of the current; while the volume of steam required to be admitted in the same time, will depend upon the area of the piston and its velocity.

In order to express these conditions in the form of an equation, let

D = diameter of cylinder in inches.
A = area of piston in inches.
V = velocity of piston in feet per second.
a = area of steam port in square inches.
$K\,a$ = effective steam port in square inches.
v = velocity of entering steam in feet per second.
s = stroke of piston in feet.
p = pressure of steam in steam chest above zero.
δ = difference of pressure in steam chest and cylinder.
h = height due to V.
C = specific volume of steam of pressure p.
r = number of revolutions per minute.

Then will

$$v=\sqrt{2\,g\,h},$$

and

$$K\,a\,v=K\,a\sqrt{2\,g\,h};$$

which represents the volume of steam admitted to the cylinder per second. But this volume is also represented by $A\,V$; hence

$$K\,a\sqrt{2\,g\,h}=A\,V;$$

whence

$$a=\frac{A\,V}{K\sqrt{2\,g\,h}}, \qquad (1.)$$

Now, $A = \cdot7854\,D^2$, and $V=\dfrac{2\,r\,s}{60}=\dfrac{r\,s}{30}$.

Substituting in (1) we get

$$a=\frac{\cdot7854\,D^2\,r\,s}{30\,K\sqrt{2\,g\,h}}, \qquad (2.)$$

To determine h, in terms of C and δ, we have but to remember that a column of steam of the pressure p, having a base of one square foot, and a height of C feet, weighs 62·5 pounds; while if the base be but one square inch, the weight of the column will be $\frac{62\cdot5}{144}$ pounds; then to find how much of this column will be required to weigh δ pounds, we have the proportion,

$$\frac{62\cdot5}{144}:\delta::C:h;$$

whence

$$h=\frac{144\,\delta\,C}{62\cdot5}=2\cdot304\,\delta\,C.$$

Substituting now this last value of h in (2) we get

$$a=\frac{\cdot7854\,D^2\,r\,s}{30\,K\sqrt{2\,g\times2\cdot304\,\delta\,C}}$$

$$=\frac{\cdot7854}{30\sqrt{2\times32\cdot16\times2\cdot304}}\times\frac{\mathrm{D}^2 r s}{\mathrm{K}\sqrt{\delta\ \mathrm{C}}}$$

$$=\frac{\cdot7854}{30\times12\cdot17}\times\frac{\mathrm{D}^2 r s}{\mathrm{K}\sqrt{\delta\ \mathrm{C}}}=\cdot00216\frac{\mathrm{D}^2 r s}{\mathrm{K}\sqrt{\delta\ \mathrm{C}}}, \quad . \quad . \quad (3.)$$

If we make $\delta=0\cdot3$ of a pound, as already indicated, (3) becomes

$$a=\frac{\cdot00216}{\sqrt{0\cdot3}}\times\frac{\mathrm{D}^2 r s}{\mathrm{K}\sqrt{\mathrm{C}}}=\cdot004\frac{\mathrm{D}^2 r s}{\mathrm{K}\sqrt{\mathrm{C}}}, \quad . \quad . \quad (4.)$$

For long and narrow rectangular ports, K may be taken as ·8, and (4) will become

$$a=\cdot005\frac{\mathrm{D}^2 r s}{\sqrt{\mathrm{C}}}, \quad . \quad . \quad . \quad (5.)$$

For circular ports, as when the puppet valve is employed, K may be taken as ·62, in which case (4) becomes

$$a=\cdot00645\frac{\mathrm{D}^2 r s}{\sqrt{\mathrm{C}}}, \quad . \quad . \quad . \quad (6.)$$

The following table furnishes a few values of C. Where the values of p differ from those given, recourse may be had to a more complete table; or, in its absence, C may be determined with sufficient accuracy by the "Law of Mariotte."

p In pounds above zero.	C	p In pounds above zero.	C
15	1669	105	282
30	883	120	251
45	610	135	224
60	470	150	205
75	383	165	187
90	325	180	174

To exemplify the application of our results, let $\mathrm{D}=100''$, $r=40$, $s=4'$, and $p=60$ pounds. Then will (5)

$$a=\cdot005\times\frac{100^2\times40\times4}{\sqrt{470}}=368\cdot75 \text{ square inches.}$$

Thus we see that, the ports being rectangular, the aggregate opening at each end of the cylinder should be 368·75 square inches. If the ports be double, and their lengths be 82 inches, their widths will evidently be $\frac{368\cdot75}{2\times82}=2\cdot25$ inches.

Again, let $\mathrm{D}=60''$, $r=65$, $s=2\frac{1}{3}'$, and $p=45$. Then will (5)

$$a=\cdot005\times\frac{60^2\times65\times2\frac{1}{3}}{\sqrt{610}}=102\cdot6 \text{ square inches.}$$

The data for these examples are taken from the "one hundred inch" and the "sixty inch" engines, now being constructed for the Navy Department; and the results are practically identical with the areas given to the ports of the cylinders of those engines. These areas were determined by the usual method, *i.e.* by making them a certain function of the areas of the pistons; whereas, it is apparent, from the formula, as well as suggested by common sense, that they should also have been made functions of the number of revolutions and the strokes of the pistons.

To prevent any misapprehension in regard to the apparent coincidence of the results given by the two methods, it is proper to remark that, had the number of revolutions proposed in the first example been 50, instead of 40, the resulting area of the port given by the formula would have been 25 per cent. greater; while the result given by the "rule of thumb" woule have been the same.

It may be said that a large cylinder would have been required, but even then the increased speed of piston would have rendered the result unreliable.

Now, to ascertain whether or not it be practicable to reduce the areas of these ports, let us solve (3) with respect to δ. We get

$$\delta=\frac{\cdot00216^2\,\mathrm{D}^4 r^2 s^2}{a^2\,\mathrm{K}^2\,\mathrm{C}};$$

whence it appears that other things being equal,

$$\delta \propto \frac{1}{a^2}.$$

Let now a_1 and δ_1 represent another area of port, and the corresponding value of δ, respectively; then we have from the relation just noticed,

$$\delta:\delta_1::\frac{1}{a^2}:\frac{1}{a_1^2};$$

whence

$$\delta_1=\delta\cdot\frac{a^2}{a_1^2}.$$

If $a_1=\frac{1}{2}a$, this becomes

$$\delta_1=\delta\cdot\frac{a^2}{\frac{1}{4}a^2}=4\delta;$$

but we have constructed our formula, and applied it upon the hypothesis that $\delta=0\cdot3$;

$$\therefore \delta_1=4\times0\cdot3=1\cdot2 \text{ pounds.}$$

Thus it appears that, in order to realise the advantages of a port only one-half as large as that now employed, we have only to increase the boiler pressure 0·9 of a pound. If a_1 had been made$=\frac{1}{3}a$, we should have found

$$\delta_1=9\,\delta=9\times0\cdot3=2\cdot7 \text{ pounds,}$$

which shows that, as the area of the port is made considerably less than one-half that which is at present employed, the excess of pressure in the steam chest over that in the cylinder soon becomes too large to be admissible.

Among the important advantages which would result from the adoption of a port one-half the present size would be: first, a saving of nearly or quite one-half in the weight of the valve, and in the steam pressure in its back; and second, a very large saving in the clearance space in the nozzles.

To best secure these advantages, the present width of port should be preserved, while the length should be reduced one-half. (5) and (6) for this case would become

$$a=\cdot0025\cdot\frac{\mathrm{D}^2 r s}{\sqrt{\mathrm{C}}} \quad . \quad . \quad . \quad (5^a)$$

for rectangular ports, and

$$a=\cdot0032\cdot\frac{\mathrm{D}^2 r s}{\sqrt{\mathrm{C}}} \quad . \quad . \quad . \quad (6^a)$$

for circular ports.

In this connexion, it may not be amiss to call attention to the (to our mind) absurd practice of making the exhaust openings and passages twice as large as the steam passages. It will be remembered that, in the first example given, the velocity with which the steam enters the cylinder is due to an excess of pressure in the steam chest of only 0·3 of a pound; while the absolute pressure, at the end of the stroke, which forces the exhaust into the condenser is—allowing for the reduced pressure due to expansion—about 51 pounds. Now, $\frac{51}{0\cdot3}=170$; or the pressure head to which the velocity of discharge is due is about 170 times as great as that to which the velocity of the steam entering the cylinder is due; and since these velocities are proportional to the square roots of their respective pressure heads, they will be to each other as $\sqrt{1}:\sqrt{170}$; or, 1 : 13. Hence, in this particular case, the velocity of egress will be 13 times as great as the velocity of ingress. With the more usual pressures of 30 to 40 pounds above zero, the velocity of egress will be about 10 times that of ingress. Even with the reduced port, in the case of the "hundred inch" cylinder, the velocities would be $\sqrt{1}:\sqrt{\frac{60}{1\cdot2}}$; or, 1 : 7.

Why, then, make the exhaust opening larger than the steam opening?

The suggestions contained in this paper are offered especially for the benefit of the younger members of the profession; and also in the hope that individuals having facilities may be induced, by the importance of the subject, to institute experiments with the view of ascertaining whether the advantages claimed for the reduced port may or may not be realised.

THE ATLANTIC CABLE, A SUCCESS.

England has fulfilled another part of her mission, and borne the olive-branch, entwining the electric cable, to America. Though we are at the point of going to press, we gladly find room for the following telegram received on Saturday, the 28th ult., from Newfoundland. Gooch to Glass.

VALENTIA, JULY 28th.

"Our shore end has just been laid, and a most perfect cable, under God's blessing, completes telegraphic communication between England and the Continent of America. I cannot find words to express my deep sense of the untiring zeal and the earnest and cheerful manner in which every one on board, from the highest to the lowest, has performed the anxious and

arduous duties they, in their several departments, have had to perform. Their untiring energy and watchful care night and day, for the period of two weeks required to complete this work, can only be fully understood and appreciated by one who like myself has seen it. All have faithfully done their duty, and glory in their success, and join with me in hearty congratulations to our friends in England, who have in various ways laboured in carrying out this great work."

We will revert to this important subject in our next.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page* 164.)

TABLE II.

Showing the highest, lowest, and average amounts of Ammonia, and total Solid Matter, in mixed samples of Rugby Sewage at different times.

—	—	Ammonia. Grains per Gallon.	Ammonia. lbs. per 1,000 Tons.	Total Solid Matter. Grains per Gallon.	Total Solid Matter. lbs. per 1,000 Tons.
1861	Highest	15·64	500·5	216·5	6,928
	Lowest	2·99	95·7	37·6	1,203
	Mean of 24 samples	6·39	204·5	75·1	2,405
1861–2	Highest	11·38	364·2	129·3	4,138
	Lowest	2·55	81·6	50·5	1,616
	Mean of 34 analysis	5·95	190·4	80·3	2,570
1862–3	Highest	12.81	409·9	269·9	8,637
	Lowest	3·14	100·5	62·2	1,982
	Mean of 35 analysis	7·08	226·5	103·2	3,302

Thus, although each sample analysed was a mixture of samples taken over several days together, as above described, there was a variation among the 93 samples of from 2½ grains to 15½ grains of ammonia, and from 37½ to 270 grains of total solid matter, per gallon; or, of from 81½ to 500½ lbs. of ammonia, and from 1,203 lbs. to 8,637 lbs. of total solid matter per 1,000 tons of sewage. Reckoned according to the number of grains of ammonia per gallon, the estimated value of the total constituents in one ton of sewage varied from about ⅝d. to nearly 4d.

Notwithstanding the very great differences in the composition of the Rugby sewage at different times, much greater, indeed, than could have been expected, considering the circumstances of the sampling, it is still believed that the mean of so many determinations may be taken as indicating, at any rate approximately, the average composition of the Rugby sewage over the period to which they refer. The probability of this will be seen on a consideration of the average results for each of the three seasons, and for the total period of 31 months of collection, given in Table III.

TABLE III.

Constituents.		Means of 24 samples, April to Oct., 1861.	34 samples, Nov., 1861, to Oct., 1862.	35 samples, Nov., 1862, to Oct., 1863.	93 samples, April, 1861, to Oct., 1863.
Grains per gallons.					
In Suspension	Inorganic ...	14·36	20·86	34·45	24·20
	Organic ...	14·16	16·84	24·03	18·85
	Total ...	28·52	37·70	58·48	43·15
In solution	Inorganic ...	36·34	34·42	36·80	35·81
	Organic ...	10·28	8·20	7·92	8·63
	Total ...	46·62	42·62	44·72	44·44
Total inorganic ...		50·70	55·28	71·25	60·11
Total organic ...		24·44	25·04	31·95	27·48
Total solid matter		75·14	80·32	103·20	87·59
Ammonia	In suspension	1·41	1·47	1·86	1·60
	In solution	4·98	4·48	5·22	4·89
	Total ...	6·39	5·95	7·08	6·49
lbs. per 1,000 tons.					
In suspension	Inorganic ...	460	668	1,102	771
	Organic ...	453	539	769	603
	Total ...	913	1,207	1,871	1,381
In solution	Inorganic ...	1,163	1,101	1,178	1,146
	Organic ...	329	262	253	276
	Total ...	1,492	1,363	1,431	1,422
Total inorganic ...		1,623	1,769	2,280	1,924
Total organic ...		782	801	1,022	879
Total solid matter		2,405	2,570	3,302	2,803
Ammonia	In suspension	45	47	60	51
	In solution	159	143	167	157
	Total ...	204	190	227	208

It is seen that the mean result of the analyses of 24 samples collected from April to October, inclusive, 1861, indicates 6·39 grains of ammonia per gallon; that of 34 samples collected from November, 1861, to October, 1862, inclusive, 5·95 grains, and that of 35 samples, collected from November, 1862, to October, 1863, inclusive, 7·08 grains. This difference in the average concentration of the sewage of the different seasons is perfectly consistent with the difference in the character of the seasons themselves. Thus, the season of 1861—2 was much the wettest, and its sewage was, accordingly, the most dilute; the season of 1862—3 was much the driest, indeed extremely dry, and its sewage was the strongest; and the season of 1861 being intermediate in this respect, its sewage was of intermediate strength.

(*To be continued.*)

Obituary.

DEATH OF MR. R. GARRETT

The death is announced, in his 60th year, of Mr. R. Garrett, the eminent implement manufacturer. While Mr. Garrett was yet a young man—to be more precise, in the spring of 1836—the business of his father at Leiston, Suffolk, to which place his grandfather had gone as a sickle maker

and bladesmith in 1778, was relinquished in his favour. At that time about 60 men and 8 or 10 horses were employed, but no steam power had yet been called into play at the works. The once insignificant village has now become a town of more than 2,000 inhabitants, all dependent on the Leiston works. The 60 work people have increased to 600, the horse-power has given place to steam power, and the name of Garrett has become known throughout Europe, in Egypt, Australia, and almost all over the world. The house of Garrett figured with honour also at the International Exhibitions of London, Dublin, Paris, Hamburgh, Vienna, and Madrid, where it won no fewer than 60 gold medals and 60 silver ones, together with £1,200 in cash, and an immense number of honourable mentions. Mr. Garrett, as wealth and honours poured in upon him, maintained the early simplicity of his habits: at the same time he gradually took a prominent position in the county affairs of Suffolk. When the East Suffolk Railway, now merged in the Great Eastern system, was brought forward, Mr. Garrett found capital to the amount of £10,000. When the Albert Memorial College at Framlingham was suggested, Mr. Garrett came forward with a donation of £500. When the volunteer movement was inaugurated in 1859, Mr. Garrett appeared as its munificent patron, and afterwards continued its steady friend.

REVIEWS AND NOTICES OF NEW BOOKS.

Useful Rules and Tables relating to Mensuration, Engineering, Structures, and Machines. By W. J. Macquon Rankine, C.E., LL.D., &c., Regius Professor of Civil Engineering and Mechanics in the University of Glasgow: London, C. Griffin and Co., 1866.

Professor Rankine's latest work is not calculated to supply any actual deficiency in our technical literature, such as was effected by him in his scientific treatment of the steam engine, the prime movers, and other kindred subjects. Indeed, we are commencing to suffer from a certain *embarras de richesse* in the line of "Engineer's Guides, "Mechanics Pocket Books," and similar compilations, and in any new publication of this kind added to our stock, we are desirous of finding something new in it, or at least to satisfy ourselves that it answers the requirements of the profession more fully than its predecessors. This can be said only to a limited extent of Prof. Rankine's work. Of the matter itself contained in these "rules and tables" very little, if any, is such as could not be gathered from other works, having, no doubt, a special character and more bulky proportions, but being on the other hand, entirely devoted to the respective subjects. Besides, the work under notice is by no means adapted to the requirements of the strictly *practical* engineer; any effectual assistance in designing, both for civil and mechanical engineering purposes, will in vain be sought for in its pages. Having premised this much, not with a view to the disparagement of this work, but to give the reader a correct idea of its objects and applicability, it is doing but scanty justice to the author and his book to say that the "Rules and Tables," though not designed for strictly practical purposes, will be found most valuable by any engineer who wishes to make out of the quintessence of scientific enquiry the foundation and corner stone of his labours in the field of practice. As a compilation of facts and figures relating to the *science* of engineering, Prof. Rankine's work is not equalled by any of those hitherto published in this country and not this quality alone, but also the style in which it is got up eminently qualify it as a scientific handbook which should not be wanting in any engineer's library. If we have any fault to find with Prof. Rankine in this respect, it is that he has carried out two literally, the promise given by him in his preface, where he says:

> The object of this book is to provide, in moderate bulk, a collection of Rules and Tables relating to those parts of mathematical and mechanical science, whose application most frequently occurs in the useful arts, and especially in engineering and practical mechanics. The use of algebraical symbols is avoided, except in those cases in which the rules cannot be clearly expressed without them.

It is perfectly just to expect a full knowledge of the rudiments of mathematics from any scientific engineer; but Prof. Rankine is greatly mistaken in assuming that an acquaintance not only with the *symbols,* but also the *substance* of differential and integral calculus is to be found amongst the profession at large to such an extent as to justify the introduction of differential quotients and integrals, whilst professing to abstain from the use of strictly algebraical symbols. There are few subjects connected with the engineering science (except *e.g.*, the calculation of maxima and minima, &c.,) in which a knowledge of these parts of higher mathematics will ever be found indispensable; and we should advise the author to avoid in future the introduction of the symbol $\int$ in any work intended for a profession, the majority of whose numbers have never had any access even to algebraical analysis, or analytical geometry. Without adverting to any other portion of the work, we may just remark that the chapter on mensuration might be somewhat more amplified without inconveniently increasing the bulk of the book: and the conic sections in particular, claim some especial attention which has not been bestowed upon them. In the Table of Measures of Capacity, page 100, those of the United States are erroneously stated to be identical with those of Great Britain; the Imperial standard gallon is = 277·274 cubic in., whilst the U.S. gallon, like the old Winchester gallon, holds only 231 cubic in.

In fine, we may say that this compilation, though it fills up no gap in our literature, will be welcomed by the engineering and industrial professions in general as a handy scientific manual, and will, no doubt, meet with the same success as most of the previous works of the distinguished author.

Chemical Addenda, being a brief exposition of the earliest features of modern Chemistry; designed as an appendix to Elementary Text Books on the Science. By the Rev. B. W. Gibsone, M.A., Lecturer in Chemistry, at the City of London College: London, J. H. Dutton, 1866.

This pamphlet contains all the general data indispensable for the student of the rudiments of the chemical science, and is the best sixpenny worth of chemistry to be found.

The Operative Mechanic's Workshop Companion and the Scientific Gentlemans Practical Assistant. By W. Templeton. Ninth Edition: London, Lockwood and Co., 1866.

We need hardly repeat here what we have said of the former editions of this little manual; notwithstanding numerous imperfections, it will be found useful by the working engineer unlearnt in mathematics and theoretical mechanics, but the "scientific gentleman" will scarcely appreciate it, as he will most likely look elsewere for *his* information.

Adcock's Engineers' Pocket Book for the year 1866: London, Simpkin, Marshall and Co., 1866.

This pocket book, in its present shape, is grafted on Weale's to which it is, in some respects, superior, in others inferior. We find in it the general engineering data, an ample and well arranged chapter on the resistance of materials and miscellaneous information a good deal of which might, however, be dispensed with. One of the chief features of this pocket book, greatly enhancing its utility, is the enlargement of the table of squares, cubes, square roots, and cubic roots up to the number of 3,000, while most other publications of this kind do not go beyond 1,000 or 1,600; a great desideratum, however, would be supplied by adding the reciprocals of the numbers and the peripheries and areas of circles; this might be effected, either by using smaller type or extending the width of the table to two pages. Some useful articles on electric bells, food in relation to the useful work, the anthracite fields of Pennsylvania, &c., also a blue wove diary are prefixed to the body of this work; we may remark that the style in which the woodcuts, illustrating the articles are got up, leaves much to be desired. The tables of foreign weights and measures are quite as imperfect as in all other pocket books, published in this country; three-quarters of the data are obsolete, and will be found worthless in practice. In drawing the compiler's attention to these imperfections, we wish it to be understood, however, that improvements in those points mentioned, will render the book more useful and secure it a greater circulation amongst the profession; but even as it stands, it bids fair to become a dangerous rival to Weale's.

Experimental Researches in Steam Shipping. By Chief Engineer, B. F. Isherwood, U.S. Navy, Vol. II. Philadelphia: W. Hamilton, 1865.

In reply to numerous enquiries respecting this book which we noticed in our issue of last month, we have much pleasure in stating that both volumes of Mr. Isherwood's work may be obtained in this country at Mr. H. Baillière's, 219, Regent-street.

NOTICES TO CORRESONDENTS.

We conceive that our duty as reviewers, ends with our notice of the contents of a book. We apprehend, that when the publisher wishes to sell the book, he advertises the price of it, that is his business; and not ours. Our New York correspondent will, no doubt, admit that the line must be drawn somewhere, and advertising is very reasonable.

A Correspondent (H., Birmingham), desires some information on the best apparatus for consuming smoke. We have seen many in operation, which were erected for that purpose, but very few so simple as to be free from some objection. In point of fact none but imposes some tax on the attention of the stoker, which attention, if he applied to the fire in his common furnace, would supersede the expense of "apparatus." Some years ago, we introduced an arrangement, on the erection of boilers, that satisfied those conditions of H. A channel was left at the back of the course of fire-bricks which lined the sides of the fire-place, one channel on each side the fire, The top row was laid without any clay between them, that is, only for bedding the bricks. Thus, so many direct

spaces were left open between these bricks, to the fire-place, from the air channel. Through these spaces, the air—now warmed—was drawn by the draught, to mix with the gases, as they escaped from the coals, and combustion naturally followed. The upper part at the end of each channel, opened also at the bridge, which enabled air again to mingle with the flame, and any uncombined gas. Combustion was so far complete, that but a very faint smoke issued, even with rough firing. Abundant steam was generated, and coals were economised.

CYCLOPS.—We have investigated the subject, and have prepared extracts of several inventions, intended for the purpose stated. To give them here would occupy too much space. Send us your address and the *resumé* is at your service.

PRICES CURRENT OF THE LONDON METAL MARKET.

	June 30.			July 7.			July 14.			July 21.			July 28.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton ...	89	0	0	89	0	0	89	0	0	84	0	0	84	0	0
Tough cake, do.	86	0	0	86	0	0	86	0	0	81	0	0	81	0	0
Copper wire, per lb.	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{1}{2}$
„ tubes, do.	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$11\frac{3}{4}$	0	1	0
Sheathing, per ton	91	0	0	91	0	0	91	0	0	86	0	0	86	0	0
B ottoms, do.	96	0	0	96	0	0	96	0	0	91	0	0	91	0	0
IRON.															
Bars, Welsh, in London, per ton	7	2	6	7	2	6	7	2	6	7	0	0	7	0	0
Nail rods, do.	8	5	6	8	5	6	8	5	6	8	0	0	8	0	0
„ Stafford in London, do.	8	10	6	8	10	6	8	10	6	8	10	0	8	10	0
Bars, do.	8	10	6	8	10	6	8	10	6	8	10	0	8	10	0
Hoops, do.	9	10	6	9	10	6	9	10	6	9	10	6	9	10	6
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do. ...	4	5	0	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do. ...	2	18	0	2	15	0	2	12	9	2	12	0	2	12	0
LEAD.															
English pig, ord. soft, per ton	20	15	0	20	15	0	20	15	0	20	15	0	20	15	0
„ sheet, do. ...	21	10	0	21	10	0	21	10	0	21	10	0	21	10	0
„ red lead, do. ...	23	10	0	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do. ...	27	0	0	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	20	0	0	20	0	0	20	0	0	19	0	0	19	0	0
BRASS.															
Sheets, per lb.	0	0	9	0	0	9	0	0	9	0	0	9	0	0	9
Wire, do.	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$
Tnbes, do.	0	0	11	0	0	11	0	0	11	0	0	11	0	0	$9\frac{1}{4}$
FOREIGN STEEL.															
Swedish, in kegs (rolled) ...	13	0	0	13	0	0	13	0	0	13	0	0	13	0	0
„ (hammered)	15	0	0	15	0	0	15	0	0	15	0	0	15	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per hottle ...	7	0	0	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.															
IC Chareoal, 1st qu., per box	1	10	0	1	10	0	1	10	0	1	10	0	1	10	0
IX „ „ „	1	16	0	1	16	0	1	16	0	1	16	0	1	16	0
IC „ 2nd qua., „	1	8	0	1	8	0	1	8	0	1	8	0	1	8	0
IC Coke, per box	1	4	0	1	4	0	1	4	0	1	4	0	1	4	0
IX „ „	1	10	0	1	10	0	1	10	0	1	10	0	1	10	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a suceinct summary of such decisions and other proeeedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the mannfacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experieneed artizan. With this objeet in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

ESDAILE v. MERCER (Liverpool County Court).—This was an action brought by Robert Esdaile, of Harford House, Fairfield, against Thomas Mercer, architect, 46, Chnrch-street, for the detention of certain plans and specifications of property for which the defendant had been architect. The plaintiff appeared in person, and Mr. Masters for the defendant. From the statement of the plaintiff it appeared that some time ago he required eertain alterations to be made in some property in London-road, and that he employed the defendant to prepare plans and specifications. After the work was completed he required ths plans in order that he might be prepared when any question as to drainage and repairs arose. The defendant declined to give up the plans and specifications. For the defence it was contended that it was the eustom of the architect to retain the plans as his own property unless a special contract to the contrary was made. Sometimes the plans were given up, but merely as a concession. The rules of the Associated British Architects were tendered to prove this point, but his Honorr would not admit them as evidence of what was the custom. The defendent called Mr. Wordley to confirm his statement as to the eustom of the profession. The plaintiff was nonsuited.

THE ATTORNEY-GENERAL v. THE STAFFORDSHIRE COPPER EXTRACTING COMPANY (Limited). In this ease the plaintiff sought for a decree to restrain the defendants from nsing eertain copper works at Oldbury so as that any vapours, gases, or smoke may be emitted therefrom, to the injnry or damage of the inhabitants of the township of Oldbury. The plaintiffs in reality are the members of the Local Board of Health, the defendants having, in October, 1864, erected works near Oldbury, for the purpose of extracting copper ore from the calcined ore. The Vice-Chancellor thought it was according to the most common sense view of the question that he should interfere, and the Local Board of Health having been empowered under their Act to take proceedings either in a court of law or equity, that was a direction to them to take the proper steps, which wonld be proceeding by indictment. The bill must therefore be dismissed with costs. On the other points as to the manufacture, there could be no doubt that there was chlorine evolved. His Honour remarked on the evidence of Drs. Anderson, Campbell, and Lse, who had detected the presence of chlorine. His Honour was clearly of opinion that it had been a nuisance, and that the steps to avert it had not been effectual. He had no doubt he must interfere and grant the iniunction, wish costs. The defendants must therefore be restrained from the 2nd of November next from carrying on the works in such manner as that any vapours, gases, or smoke may be emitted therefrom to the injury or damage of the inhabitants of the township of Oldbury, or any of them.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have reccived many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their iuterests are conneeted with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

ASSESSMENT OF MACHINERY.—The Assessment Committee of the Clifton Board of Guardians, recently discussed the above as a question of importanee to them. The property in St. Philip and Jacob has been revalued, and a new principle applied to the assessment of machinery in a cotton factory, the Avonside Iron Works, collieries and other properties, in many cases doubling the rateable value, and in many others actually trebling this value. The owners appeal to this committee involved a long discussion; the latter came to the following resolution:—"That the deductions to be made upon the gross assessment of the buildings, including motive power and machinery be based upon the relative values of machinery and plant to buildings and land, and that the amount of such deductions be left to the consideration of a sub-committee." This course proved unsatisfactory to the appellants, it was therefore resolved to hear the cases. The gross assessment fixed by the surveyor for the iron works was £2,450, and the rateable value £2,082. This was appealed against, for a reduction to £1,915 15s. 6d., and £1,628 being 5 per cent. on the value of the property. The surveyor it appeared had taken the land at 4 per cent., the freehold property and building (including steam engines, shaft, and motive power) at $7\frac{1}{2}$, and the machinery including lathes, &c., at 10 per cent., and refused further explanation. As to the cotton works the building and motive power had been taken at $7\frac{1}{2}$, and other machinery at 10 per cent. The object of the committee appeared to be to hear the applicants, as no decision was given after sitting over six hours.

STEEL.—The success of Mr. Bessemer has impressed many, that he has not exhausted the subject of the manufacture of iron and steel. His process has supplied the required clue. Some have taken up the subject where that process left it, and by a thorough manipulation, they have considerably increased the strength of iron. The Besssmer ingots have been reheated, and put through a process of hammering. To form a cylinder for a heavy gun, or for a light rifle, the hammered mass of iron is further condensed by the use of a punch, which is made to move radially from a point equidistant from the extremity. A mandril is then inserted, and the mass is elongated by being passed through rolls to improve yet more the quality of the metal, and to impart to the steel an accuracy of dimensions. It is inferred, that these manipulations involve at least six times the amount of work on the steel afforded by any other treatment hitherto adopted, and results in improved strength and solidity of texture. We hear of this process being about to be applied to 7in. tubes for ordnanee, hollow, marine, and other shafting, railway axles, locomotive, and marine tubes, &c. John Brown and Co., of Sheffield, and also other parties in Birmingham, have been conducting extensive experiments with this process. The results hitherto have been very satisfactory.

HORSE CLEANING BY MACHINERY.—"At the establishment of the Manchester Carriage Company, Pendleton, there is now in practical operation a novel and ingenious system of cleaning horses by means of a steam brushing machine. The idea has evidently been derived from the revolving brush which many hairdressers have had in use; but the application of the idea to horse cleaning is of such utility, and has had so great an effect in economising labour, that it is worth a public notice. On an omnibus horse heing brought into the stable after his three hours' work—during which, in any kind of weather, he removes from the roads of Manchester and Salford an almost incredible quantity of dirt—he is taken to this shed, and a man applies to him the machine brush. In about half-an-hour the animal is thoroughly cleaned, and only the head requires finishing by hand. The cleaning effected by the machine is much more searching and effeetual than the most diligent hand currying can possibly be; and to the majority of animals the greater cleanliness of their skins, as well as the improved eireulation of the blood which is produced by the machine brush, appear to be acceptable. Under the old system, a man was thought to have done a fair day's work if he cleaned ten or a dozen horses; but by the machine he can clean thirty in the same time, and with considerably less bodily labour."

THE COAL QUESTION.—The Royal Commission appointed to investigats this subject has bsen duly gazetted to consist of the Duke of Argyle, K.T., Sir Roderick Impey Murchison, Bart, K.C.D., Sir William G. Armstroug, C.B.; Henry Hussey Vivian, Georgs Thomas Clark, Joseph Dickinson, George Elliot, Thomas Emerson Forster, John Gsddes, Robert Hunt, John Beete Jukes, John Hartley, John Percy, Doctor of Medicine; Jossph Prestwich, Andrew Crombie Ramsay, and John Thomas Woodhouse, Esquire's, ths duties of the Commissioners, are defined in the following terms, viz.: to investigate ths probable quantity of coal contained in ths coal fields of the United Kingdom, and to report on the quantity of sueh coal whieh may be reasonably expeeted to be available for

use; whether it is probable that coal exists at workable depths under the Permian New Red Sandstones, and other superincumbent strata, to inquire as to the quantity of coal at present consumed in the various branches of manufacture, for steam navigation and for domestic purposes, as well as the quantity exported; and how far, and to what extent such consumption and export may be expected to increase, and whether there is reason to believe that coal is wasted, either by bad working or by carelessness or neglect of proper appliances for its economical consumption.

Tunnelling the English Channel to open a road into France.—This project has not been permitted to lay dormant, it is full of the activity of preparation. We are informed that Mr. Hawkshaw confirms the idea with his approval, and is now actually giving gravity to it, by a series of borings under his direction, to help him to a final decision. These borings have been begun at Dover, and by permission of the French Government, other borings have been made between Calais and Boulogne. In the course of the fine summer weather now expected, other similar explorations will occur across the channel. Whenever the tunnel is decided on, no doubt that operations will commence at both shores simultaneously, to meet wherever they may on the intended line. Of course there must be powerful pumping engines, and other engines for excavating, raising the excavated material, and to supply other requirements. It is expected that a communication will be made on the French side with the Northern of France Railway, and on the English side with the South Eastern, and London, Chatham, and Dover Railways, affording an unbroken line of railway from London to Paris. It may be 25 years before these things are realised, and the expenditure is expected to be not less than £20,000,000.

Furnace Slag.—A very simple and ingenious step has been taken in France of getting rid of the nuisance of "cinder tips,' by granulating the slag, as copper is granulated in the process of smelting it. The hot slag, as it flows from a furnace, runs into a reservoir of water, from whence it is drawn as sand. In this state it is very useful for a variety of purposes.

The Dock Yards.—The papers advise us of a "thundering onslaught" in the Commons contemplated by a miller, who has "a seat" there. He has made the immense discovery that they have been using that worthless class of iron, yet good enough for "pig ballast," to build walls for "clinker house," and to "pave the chain cable store and testing house." Let him expose his own folly, it is uncharitable to impute folly to him.

Progress of Leith.—It is not our province to indulge in the descriptive, but simply employ it to convey some idea of the doings of the artizans and monied men of Leith, and of the expanding requirements of its trade and commerce. In 1861 the population of Leith was 33,628 inhabitants, and the annual value of its real property was £150,642. The population is now estimated at 36,000, and the annual value of its real property at £190,000. In these five years the Corn-exchange has been built, and also extensive stores, saw-mills, dwelling-houses, churches, chapels, several ranges of warehouses, a large flour mill (at a cost of £12,000). Operations are in progress for extending the Caledonian Railway to Leith, and to enable the trucks on this line to be loaded or discharged in the docks alongside of the shipping. Owing to the increase of business requiring increased accommodation, some established firms have been compelled to enlarge their premises. New docks have been begun, and are in active progress, but their completion is not for the present to boast of, such solid structures extend into the future. The same remark applies to the yet unfinished enlargement of the North British Railway Company's Citadel station. When complete, the new station will extend from Johnson-street to Admiralty-street, and from Commercial-street to Cromwell-street. The sugar-house, which is nearly completed, is rather an extensive affair. The machinery and internal fittings are so far advanced, that in a few weeks the manufacture of refined sugar may be commenced. This house is the largest of its kind in Scotland, with the exception of two or three in Greenock. These works when in full operation, are expected to refine 600 tons of raw—that is, imported—sugar per week. The main building is 82ft. in length, 44ft. in breadth, and is eight storeys in height. Over the entire roof is an immense iron cistern capable of holding 100,000 gallons of water. There will be twenty-seven cisterns in other parts of the building, each 9½ft. in diameter and 16ft. in height; also six kilns. Over the engine-house is a large water cistern, covering the whole of that area. There are the usual offices, as cooperage, cone-sheds, warehouse, manager's house, &c. These premises occupy about two acres of ground. The original estimate was £30,000, but, it is believed that that sum will not cover the outlay. Adjacent to the sugar-house is an extensive brewery 250ft. long, 75ft. broad, and four storeys high, with malt kilns, &c. complete. Premises for three engineering firms have been commenced in Leith, within the past few months, and several large blocks of warehouses and lofts are in course of erection. So also large additions and alterations are contemplated; those for instance, to the already extensive flour mills of the Messrs. Tod, in North Leith. These mills had forty-five pairs of stones propelled by steam engines of 400 horse-power. The addition will bring the number of pairs of stones up to seventy-two, and the horse-power to 800. The new portion of the mill will have a frontage of 122ft., and will be seven storeys in height. A portion of the new building will be fire-proof, and connected with the existing mills by iron gangways or bridges. Extensive grain and flour stores are to be built behind the mills. This frontage will be 110ft., and the height of six storeys. The floor-space will be upwards of 14,000ft. super. The carts on entering the premises will be loaded or unloaded under cover, and will pass through without the necessity of turning. This mill and stores are expected to be finished by the end of the season.

Peat.—The consumption of peat on the New Haven Railway is at the rate of 46lbs. per mile. On the Hudson River Railway the consumption of coal is 24lbs. per mile.

Preservation of Timber.—When extending some mine operations recently in Spain, the miners laid open no less than eight wooden wheels, that had been erected under ground for the purpose of raising the water by manual labour. The arms and rims are of fir, the axle and its support of oak. Although these wheels are supposed to be some fifteen hundred years old, they are in a high state of preservation, being immersed in water charged with the salts of copper and iron, thus preventing fermentation, which is the process of decay of vegetable matters. From their position and construction these wheels are supposed to have been worked by men standing on the rim. The water was thus raised from wheel to wheel through the eight stages.

Mowing Machines.—A correspondent in the *American Artizan*, taking his experience for a guide, is of opinion that the machine cuts two inches closer than the scythe, and thus increases the quantity of hay by one-eighth. Thus, the machine can get 40 tons of hay when the scythe can get only 35 tons; the price of the machine may thus be saved in three years, without noticing the great saving in labour.

Paraffine.—The shales in Fifeshire yield about 30 gallons of crude paraffine, and 12 gallons of ammoniacal liquor, per ton of shale. The cannel coal of Hucknal Forckard Colliery, in Northamptonshire, yields 43 gallons of oil to the ton.

Explosion at Abbeyhill Brewery.—The *Weekly Scotsman* of the 7th ult contains the following interesting narration of a singular occurrence. It appears to deserve a closer investigation of attendant facts:—An explosion occurred at Mr. G Pendreigh's Abbeyhill Brewery, from the effects of which the roofs of two buildings were blown off. On investigation, the explosion was found to have occurred primarily in the mill-house. The malt after being ground is called "smeddon," and this stuff is said to be almost as explosive as gunpowder. From the mill the "smeddon" is conveyed by means of elevators, with the ordinary mill machinery, up into the "groune hopper," where it stands ready for mashing. The friction of the belt, it is supposed, caused fire, which was communicated to the "smeddon" in the enclosed elevators, and an explosion ensued. The expanded air burst the elevator at the belt wheel, rushed in an oblique direction against the mill wall, shook it considerably, and blew the roof off the building. The heated air also escaped to a malt-loft adjoining, and burst open a part of the roof. The miller was in the mill at the time of the explosion, but he miraculously escaped from the falling tiles and timber. The damage done is considerable, as besides the destruction of the roofs, the wall of the mill is so injured that it will require to be rebuilt.

Workmens' Strikes, and the Main Spring of their action.—Without troubling ourselves with the *pros* and the *cons* of this matter, we may be consulting the facts and the interests of the men in finding space for an extract from the *Weekly Scotsman* of July 14th. We naturally infer the motives of a mans' actions from his character. Honesty and integrity are so closely allied, that when one of them is absent, the other is as often found wanting victims, and dupes are often associated, if not identical, yet they but seldom so effectually expose the instigation and preparation of crime, as in the case before us. A few more of such examples as the following may be productive of a healthy understanding between the workman and his employer:—Henry Hughes, who described himself as conductor of the miners' strike in Bellshill in April last, was brought before Sheriff Logie at Airdrie, charged with having embezzled the sum of £4, with which he had been intrusted by the Baillieston branch of the Miners' Association to deliver to Mr Alexander M'Donald, miners' secretary, Holytown, for the relief of the men then on strike at Carfin. Hughes conducted his own defence, and endeavoured to prove by cross-examination that the money had been given to him as "manager of the strike," and that nothing had been said at the time he received it about handing it over to M'Donald. A receipt granted by Hughes for the money was produced, and from this it appeared that the money was for distribution. The prisoner stated that he supposed the money had been given him to distribute as he thought proper among the Carfin men, and a balance of £1 3s. he held as an allowance to shift his family elsewhere. The Sheriff found it proven that Hughes had only received the money in trust to give to M'Donald, and therefore found him guilty as libelled, and sentenced him to thirty days imprisonment.

FIRE INSURANCE DUTY.

The Parliamentary return of the Insurance duty paid in 1865 has just been published, and is the last return which will embody the differential rates on Stock (1s. 6d. per cent.) and on buildings and furniture (3s. per cent.). For the purpose of comparing the business of each company in 1865 with that of 1864, our contemporary, the *Daily News*, makes up the following account for the two years as though the duty had remained at 3s. per cent. We thus get a measure of the progress of each company, and the result is as follows:—

Increase in 1865 over 1864.

Royal	£17,708	Scottish Provincial	£693
Alliance and Birmingham District (Amalgamated	5,690	Caledonian	684
Phœnix	4,983	Hercules	579
Sun	4,882	Kent	530
North British and Mercantile	3,376	Royal Farmers	473
Queen	3,146	Patriotic	435
Western	2,960	Northern	373
Norwich Union	2,814	Church of England	350
Law	2,753	Salop	268
London and Lancashire	2,575	Norwich Equitable	245
County	2.475	British Nation	245
Commercial Union	2,185	Nottinghamshire and Derbyshire	241
London	1,804	Yorkshire	188
London and Southwark	1,716	Prince	155
Scottish	1,714	Emperor	153
Manchester	1,607	Lancashire	124
Birmingham Alliance	1,583	Midland Counties	112
Albert	1,431	Essex and Suffolk	94
Home and Colonial	1,319	City and County	87
General	1,310	Friend-in-Need	70
West of England	1,224	Royal Exchange	63
Guardian	1,174	Shropshire and North Wales	60
Atlas	1,168	Birmingham	33
Law Union	990	Netherlands	28
Scottish Union	824	Preserver	4
Provincial	760	Stewarton, Dunlop, and Fenwick	3s.

Decrease.

Oldham	£4	Union	£490
National of Ireland	12	Imperial	767
Volunteer Service and General	109	Westminster	942
Scottish National	157	Liverpool and London and Globe	14,471
Hand-in-Hand	221		

The above statement, deduced from a return made to Parliament, and ordered by the House of Commons to be printed, 19th June, 1856, proves once more on the authority of public documents, that the "Royal" is increasing its Fire business far more rapidly than any other Insurance Office in Great Britain and Ireland.

Tact and Courage of an Engine-driver.—An extraordinary escape of a runaway engine and carriages took place on the North London Railway on Monday evening. In the absence of the driver, a fireman attempted to shunt his engine and train at the Stratford-bridge station without the aid of a pointsman. Having put the engine in motion he got down and held the points while the train passed over, but before he could regain the engine it had attained increased speed, and proceeded without anyone upon it. The escape of the train was immediately telegraphed to the various stations, and most providentially the line was comparatively clear. The engine rattled over the Hackney Wick Junction along the main line, through Hackney and Dalston Junction. When it passed Hackney, a train for Fenchurch-street was in the station, and Amy, the driver of the engine attached to this train, immediately unhooked his engine, and crossing over to the down line started off in pursuit of the runaway engine, and came up with it on the line between Dalston and Shoreditch stations, and succeeded in coupling his engine to it. Had the escaped locomotive rushed into the Broad-street station sad destruction must have ensued. It is most fortunate that there were no trains passing along the main road when the engine ran past the several junctions.—*Daily News.*

Artificial Gas Coal.—Under this head the *Mining Journal* affords us information of experiments made by Mr. G. Mackenzie, of Glasgow. The novelty consists in mixing small coals, which is but of nominal value at the pits, with the heavy oil obtained as a by product in the manufacture of mineral oils, and which is comparatively not marketable. Thus both elements range on the side of economy, and their gaseous products must be freer from those deleterious gases, which sorely puzzle our engineers and chymists to retain in the purifyers. Mr. Mackenzie maintains, that on the one hand we have a material deficient, and on the other, one that is rich in carbon. The results are likely to prove of incalculable importance to the gas companies, and the crude oil manufacturers, and we may add, to coal owners, and gas consumers in general. He estimates the cost of this mixture at 20s. per ton, and that one ton will give 16,000 cubic feet of gas, equal, in illu-

minating power to 32 sperm candles. The cost of Lesmahago gas coal, is at present about 30s. per ton, and yields about 9,000 cubic feet of gas. Its coke is sold at 5s. per ton, whilst the coke from the above "mixture" is worth 20s. per ton for foundry purposes.

The Needle-Gun.—Captain James Whitley, in a letter to a contemporary, lays claim to be the originator of the needle-gun. This gentleman says: "I perfected a breach-loading needle-gun, in 1823," and adds, "The original needle-gun can be inspected at the factory of Mr. Calderwood, gunsmith, in Sackville-street, Dublin, together with its cartridge." This is good, so far as the original idea is concerned, and it may have satisfied the originator with its "practice." How much farther it proved itself useful, we are not told; yet a few more facts might have been accumulated in the hands of the military gentleman, and the respectable gunmaker, which, if favourable, must have pressed the invention on public notice.

NAVAL ENGINEERING.

An Iron Dredger was launched on the 29th ult., at Moreton's Dock, Leith; she is 116ft. long, and 36ft. broad, with bucket ladders on each side, working in wells 5ft. wide. The bucket ladders are 74ft. long, from centre to centre. The engines are of 50 horse-power. This dredger is intended for the River Wear Commissioners.

The "Kaikoura" arrived on the 5th May, at Melbourne from Plymouth, making the passage in fifty-one days. The *Kaikoura* was intended to leave Sydney on the 15th of June, and Wellington, New Zealand, on the 23rd with the first mails from this country *via* Panama.

A Post Office Return shows that in the year 1864, the *City of New York* steamer, and the *China*, both made the passage from Queenstown to New York, on one occasion in 8 days, 16 hours, and the *Scotia* in 15 minutes less. In the same year the *Scotia* made the passage from New York to Queenstown in 8 days, 15 hours, 38 minutes; and the *China* from Boston to Queenstown in 8 days 14 hours 50 minutes. In 1865 the *China* went from Queenstown to Boston in 8 days 22 hours, and the *Scotia* from Queenstown to New York in 8 days 19 hours and 33 minutes, and in that year the *Scotia* made the passage from New York to Queenstown in 8 days 15 hours 15 minutes, and the *China* from Boston to Queenstown in 8 days 11 hours. In the two years, the average time of the *Scotia* from Queenstown to New York was 9 days 19 hours 12 minutes, of the *China* 12 days 13 hours 7 minutes, but to Boston only 9 days 22 hours 31 minutes. In the converse voyage the *Scotia* from New York to Queenstown, averaged 8 days 23 hours 49 minutes, the *Java* 9 days 46 minutes, the *China* 9 days 22 hours 42 minutes, but from Boston 8 days 20 hours 5 minutes.

TELEGRAPHIC ENGINEERING.

The Northern Overland Telegraph is a gigantic affair. Through British America, 1,200 miles; through Russian America, 900 miles; across Behring Strait, 184 miles; across the Gulf of Anadyr, 300 miles; and thence overland to the mouth of the Amoor River, 1,800 miles; or a total of 4,294 miles. At the Amoor, it is to be continued by a Russian line connecting it with Irkoutsk, through Western Siberia, communicating with Nijul, Novgorod, and Moscow, and thence to St. Petersburg. The capital involved amounts to 10,000,000 dols.

RAILWAYS.

The Caithness Railways.—Engineers are expected to commence forthwith, the survey of the county, for the extension of the through line. Arrangements are being made to go to Parliament next session with a bill authorising the completion of the whole work, extending the line to Thurso and Wick.

It is intended to amalgamate the Vale of Neath Railway Company with the Great Western.

The Wycombe Railway, it is expected, will soon be absorbed in the Great Western.

The Lancashire Union Railway Company propose to construct new railways in the townships of Parr, Haydock, and Ashton-in-Makerfield, Lancashire.

The Halesowen and Bromsgrove Railway Company has decided to attempt the making of branch railways and extensions of its line.

The Pembroke and Tenby Railway Company proposes the extension of its lines to Milford, and from Whitland to Carmarthen.

The North-Western and Charing Cross Junction contemplate a station at the junction of Tottenham-court-road and the Hampstead-road; also another at the junction of Oxford-street and Tottenham-court-road.

The Midland Railway Company is promoting a bill for improving the communication between Ashby-de-la-Zouch, Nuneaton, and other places, by a line nineteen miles in length, with branches to coal-fields about nine miles long.

The Chatham and Dover Railway Company entertain the proposal to make railways from the South-Eastern and London, Chatham, and Dover Companies' Railways' to various districts and places in Kent, Surrey, and Sussex, to the towns of Lewes and Brighton, and from Maidstone to Ashford.

The Tendring Hundred Railway Company's extension line to Walton-on-the-Naze will be shortly opened as far as Kirby Cross, two and a half miles from Walton. The preliminary inspection has taken place by the Board of Trade officials.

There is at present a bill before Parliament which is promoted by Lord Redesdale, entitled "The Railway Traffic Protection Bill." It is hoped that some modification of, or addition to it, will also protect the claims of creditors. No doubt this will be duly provided for. The principle of the bill is that "It shall not be lawful for any creditor to seize or take in execution, in satisfaction of any debt incurred after the passing of this Act, any engine, carriage, rail, or other property, on any railway of any kind whatsoever which is or may be required for the due performance of the service of passenger or goods traffic thereon." Lord Redesdale explained, that its object was to prevent the seizure of railway plant, which frequently entailed great inconvenience. What he wished, was, to establish the principle that railway property should be protected from the claims of creditors, so that the public traffic should not be in danger of being stopped by the seizure of the railway plant.

Mersey Railway.—Royal Assent.—The bill for the construction of this railway, whereby Liverpool will be connected with Birkenhead, and with which Mr. de Metz, Messrs. Lace, Banner, Gill, and Bardswell, and Sir Charles Fox, and others are connected, in the relative positions of projectors, solicitors, and engineers, has received the royal assent. This railway, which is intended both for passengers and goods traffic, will extend from Church-street, Liverpool, to Woodside, Birkenhead, with an intermediate station at the bottom of James-street, Liverpool; and can be brought into direct communication, by means of hydraulic hoists, with the dock lines of railway, which are connected with the existing railways on both sides of the river. The undertaking has been supported on public grounds, by Messrs. R. Gladstone, Edward Lawrence, Harold Littledale, and other well-known and influential local gentlemen; and the bill was brought into the House of Commons by Mr. Horsfall, M.P. for Liverpool, and Mr. Laird, M.P. for Birkenhead.

During the last year, on the New York steam railways, 227 persons were killed, and 272 wounded. On the Pensylvania railways, for the year ending October 31st, 1865, 385 were killed, and 582 wounded; total for the two states, 1,466 killed and wounded. Two years ago we were told, by the locomotive superintendents, that no passenger had ever been killed on the New Jersy railwasy; and we have recently seen a report that no passenger has been killed on the Prussian railways. These are presumptive evidences that passengers may be carried safely. And, considering the mechanism with a view to safety, as well as to economy and convenience, we are of opinion that in case of derailment, breakage of axles or other accidents likely to occur when there is no obstruction, on a tract that is in order no car need be broken up and no person need be hurt. And we are further of opinion that if railways had to pay 10,000 dols. per passenger killed, and full damages for injuries, there would be no damages except from collisions with trains, or obstructions on the line.—*American Artizan.*

DOCKS, HARBOURS, BRIDGES.

The Suspension Bridge at Cincinnati will be the longest in the world, its total span being 3,171ft.. Its estimated cast is 1,750,000.

A New York paper informs us, that the rail road, running from St. Louis to Springfield, was sold od the 13th of May to John C. Fremont, for 1,300,000 dols. Seventy-seven miles of this road have been completed.

STEAM SHIPPING.

The Tonnage of Vessels.—The *Gironde* of Bordeaux calls the attention of shipowners, those interested in Maritime affairs, and of the Government, to a question of real importance, the fixing the tonnage of vessels. It appears the system adopted in France gives a result superior to that employed in different foreign countries. A French ship carrying an equal quantity of goods, to that which a foreign ship of equal dimensions receives, is regarded as presenting superior tonnage, and has, consequently, higher duties to pay at Havana, Manila, &c. In England, a Bill on the subject is now before the House of Commons. The system of measurement adopted in England in 1854 having caused complaints, was modified in 1860; but these modifications are now severely criticised, and have led to dispute between shipowners and the customs. We must in France observe attentively what our neighbours do in the matter, and place the question on the order of the day.

The Steamship "Collingwood," built by Messrs. J. Wigham Richardson, and Co., Low Walker, for the Shields Steam Shipping Company, had a trial trip to sea on the 28th of June, which was highly satisfactory. The *Collingwood* left Low Walker at five-o'clock in the morning, and steamed down Shields harbour to sea, to adjust compasses, bringing up across the bar. At eleven o'clock the steamer *Wards*, having on board the chairman and directors of the company, with a number of their friends, including several of the members of the Tynemouth and South Shields Corporations, left the Shields Steam Shipping Company's Wharf, North Shields; and proceeded across the bar to the *Collingwood.* The vessel was under the command of Captain Green, and Mr. Thomas Freeman, of South Shields, officiated as sea pilot. The *Collingwood* was launched on the 14th of May this year, and the following are her dimensions:—Length over all, 200ft, breadth, 27ft.; depth, 16ft.. The steamer is intended for the passenger traffic and goods trade between Shields and London; and accommodation is afforded for twenty-five first class passengers, and twenty second class passengers; while 700 tons of goods can be carried by the vessel. For first class passengers a splendidly fit-up saloon is placed amid-ships. It is fitted with solid oak, having beautifully painted landscapes in the panels. The comfort of first class passengers, and especially the ladies, has been carefully studied. For their accommodation every provision has been made, and the births occupied by them will be fitted up with every requisite for the toilet, &c There are also single and double berths, and small state-rooms, and these are arranged in a style of great comfort for those who embark on board the *Collingwood* for a trip to the metropolis. The engines of the steamer, of 100 horse-power, are by Messrs. Hawthorn, of Newcastle, and they are of a first class description. The vessel has on board three steam cranes to facilitate the loading and unloading of goods. She is also fitted with water ballast apparatus, and is brig rigged, with Stock's patent jack-stays. She is likewise fitted with Clifford's boat lowering gear, supplied by Messrs. Trotter and Sons, North Shields. Altogether the steamer in point of build and fit out is of a first class description. She is a splendid model, and does her builders the greatest credit, and the company on board spoke in the highest terms of her. The carved work—head and stern—is by Mr. W. Allan, of Jarrow. After the company had got on board, the *Collingwood* proceeded as far as the Coquet, steaming rather above eleven knots per hour. About half-past five o'clock the steamer was set away on the return home. After proceeding a short distance, Clifford's apparatus was tried, by the lowering of one of the steamers' boats, which was most successfully accomplished. Shortly aftewards, the company proceeded to the saloon, where refreshments were partaken of. The Mayor of Tynemouth occupied the chair; Mr. James Hunter, the vice-chair. In the course of the toasts which were given, Mr. Alderman Taylor, in giving "The Health of Mr. Ure;" engineer to the River Tyne Commissioners, referred to the great improvements which had taken place in the Tyne. When he was a sailor boy, some thirty-five years ago, he remembered that a vessel drawing 12ft. of water had sometimes to wait two or three weeks before she could get to sea through want of water. To his talented friend, Mr. Ure, who was an engineer of the first eminence, they were indebted for the improvements that had taken place in the Tyne. A few years ago large vessels went to Sunderland and other ports to load steam coals, but now they came to the Tyne: and he had no doubt if these improvements to which he had referred continued, the Tyne would soon be in a position to compete even with Liverpool. No doubt large sums had been spent, but if they got interest for it in an extension of the trade of the port, they ought to be exceedingly glad.

MINES, METALLURGY, &c.

At the recent meeting of the Severn Valley Field Club, at Lilleshall, Mr. Jones read a paper which was of great general interest, owing to the bearing it had upon the question of the extension of the Shropshire and South Staffordshire coal fields. He observes that the Crow Hay Pits are situate about 130yds. east of the Lightmoor Fault, which is a downcast of 920ft. These pits were started forty years ago, with a view of winning limestone. The sinking was hard and tedious in the Permians. The old sinkers called them the limestone rocks of the district, but were convinced to the contrary when they came to the Pinney ironstone and the lower coal measures of Shropshire. It was abandoned after a head had been driven in the New Mine coal to the Lightmoor Fault, as it was the prevailing opinion in those days that no limestone would be found below the coal measures. He resumed the sinking about twenty years ago, and at 60yds. below the Little Flint coal found a band of limestone about 1ft. thick, and at a depth of 240yds., but the "grap" similar to the surface of the hill. Singular to say, the sinkings were comparatively dry throughout. These pits are the same distance from the Lightmoor Fault as the Granville. The Granville is 400yds., and the Crow Hay 150yds. to the Clod coal. We have all the series at the Granville lying horizontally, at the Crow Hay the lower series only, and dipping 1 in 7; but as they recede from the Fault they will become more horizontal. The Granville winning is developing itself on all sides. The coal field is entire from there to Crow Hay and north of that, and in all probability extends for a considerable distance in an easterly direction under the New Red and Permians, containing millions of tons of coal, that will not only supply our wants, but the wants of future generations yet unborn.—*Mining Journal.*

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan.

Dated June 22nd, 1866.

1662 T. Godfrey—Strengthening the vulconite base used for artificial teeth
1663 C. P. Henry—Improvements in paving roads
1664 W. Smith—Improvements in the manufacture of trimmings
1665 J. Girvan—Improvements in reaping machines
1666 J. Parker—Motive power apparatus
1667 E. Hunt—Dissolving or treating difficultly soluble gums or resins
1668 C. A. Dufour—Metallic packing for stuffing boxes
1669 G. Turton—Improved rotary engine
1670 T. Whitley—Springs for railway and other carriages
1671 E. Peyton—Improvements in safes
1672 W. Eades and W. T. Eades—Apparatus fur raising weights
1673 C. De Grelle—Cutting, grinding, and polishing the bottoms of tumblers
1674 A. V. Newton—Construction of rotary engines

Dated June 23rd, 1866.

1675 G. Davies—Improved steam gauge
1676 T. Deakin—Improvements in overhead railways
1677 T. Dunn—Machinery for turning and cutting metal
1678 H. Gardner—Cases for packing and transporting bottled ales and other liquors
1679 P. Barlow—Exhibiting the time on the dial plates of clocks and watches
1680 A. Lee—Preparing wool or other animal fibrous substances for dyeing
1681 H. Hill—Working of railway signals and switches
1682 W. Ponpard—Apparatus for screenig coals and other materials
1683 T. S. Hudson—Machinery for printing surfaces or cancelling revenue or other stamps

Dated June 25th, 1866.

1684 W. Welbourne—Improvements in canisters for containing tea or other substances
1685 E. Hemingway—Looms for weaving Dutch carpets by power
1686 E. G. Brewer—Improved coupling for railway carriages
1687 E. G. Fitton—Machinery for preparing and spinning flax
1688 C. E. Brooman—Locks or fastenings
1689 C. E. Brooman—Wood screws
1690 J. Reading, S. A. Reading, G. E. Reading, and F. F. Reading—Fastenings for articles of dress
1691 T. P. Saville—Breech loading firearms
1692 W. E. Newton—Improved spirit meter
1693 G. Charles-Auge—Treating corn and other materials
1694 E. Field and F. Wise—Generating steam or heating liquids

Dated June 26th, 1866.

1695 H. Sullivan—Instrument for writing
1696 A. Clayton—Registering the flow of water through pipes or orifices
1697 J. Young—Apparatus for the treatment of hydro-carbon oils
1698 C. F. Cotterill—Manufacture of earthenware and other pipes
1699 C. P. Holliss—Improvements applicable to axle trees of railway carriages
1700 W. Buckley and L. Smith—Piston of a steam engine
1701 J. Milroy—Apparatus for excavating
1702 W. E. Gedge—Manufacture of blocks or pulleys by machinery
1703 W. R. Lake—Improvements in the manufacture of white lead
1704 S. Cyr Radisson—Improvements in printing on woven fabrics
1705 C. Beeching—Ships to be employed in conveying liquid cargoes

Dated June 27th, 1866.

1706 E. Ambrose—Improvements in Venetian blinds and blind fittings
1707 H. Medlock and W. Bayley—Preserving animal substances
1708 J. Northend, J. Holmes, W. Hopkinson, and William Bibby—Combing wool and other fibrous substances
1709 W. Fairbank—Apparatus for generating and reserving steam
1710 W. R. Lake—Separating volatile products from oils and other fluids
1711 T. Kennedy and James Barr—Pistons and cylinders
1712 W. H. Fyfe—Apparatus for making bricks
1713 R. H. Clydesdale and J. E. Wilson—Finishing tobacco
1714 J. Jordan—Application of certain spirituous compounds for the production of motive power
1715 J. Henshall—Machinery for cutting files
1716 H. W. Hart—Preventing the accumulation of dirt on carriage wheels
1717 W. E. Newton—Raising and forcing water from vessels
1718 J. Baker—Thermo-electric magnetic batteries and engines
1719 W. Wyatt—Screens for screening grain and other substances
1720 B. F. Weatherdon—Preventing incrustation in steam boilers

Dated June 28th, 1866.

1721 H. D. Plimsoll—Application of a new material to the purpose of rendering gunpowder non-explosive
1722 W. E. Gedge—Manufacture of metal boxes
1723 D. Dawson, D. Dawson, and T. Broadbent—Means of extinguishing fire in steam ships
1724 J. H. Johnson—Apparatus for cleaning pulse grain and seeds
1725 F. T. Hubert and H. D. G. Truscott—Construction of general electric telegraph machines
1726 C. E. Brooman—Obtaining alkaline permanganates
1727 S. C. Lister—Machinery for preparing silk waste
1728 D. K. Clarke—Improvements in locomotive traction engines
1729 S. Deacon—Machinery for drilling iron and other metals

Dated June 29th, 1866.

1730 T. Smith—Machinery for facing the surface of stone
1731 L. S. Pilkington—Washing machines
1732 W. Thomson—Actuating the points or switches of railways
1733 J. Ashton—Manufacture of studs and buttons
1734 H. Hobson—Smelting iron ores
1735 J. Imray and J. Ellis—Carriage windows and other sliding frames
1736 W. Clark—Embroidering machinery
1737 S. Holmes—Manufacture of printing ink
1738 R. Hornsby—Mowing and reaping machines
1739 J. H. Johnson—Brickmaking machines
1740 H. Griffin—Combining indiarubber with metallic substances for the manufacture of valves and other uses

Dated June 30th, 1866.

1741 J. Humber and G. Haworth—Material for covering rollers used in the various processes of making cotton
1742 F. Kahot and J. Bunting—Manufacturing of cutlery handles
1743 M. L. J. Lavater—Improvements in brackets
1744 J. Jackson—Improvements in lamps
1745 T. Macneill—Construction of railway rolling stock
1746 T. F. Gillot—Manufacture of leather
1747 C. D. Knapton—Spinning frames

Dated July 2nd, 1866.

1748 W. J. Baker—Apparatus for facilitating the passage of a guard along the outside of a railway passenger train in motion
1749 H. A. Bonneville—Construction of submarine telegraph cables
1750 H. A. Bonneville—Safety lock
1751 H. A. Bonneville—Construction and laying down of subterraneous telegraph wires
1752 H. A. Bonneville—Construction of furnaces and kilns
1753 H. A. Bonneville—Applying heat to certain parts of the human body
1754 H. A. Bonneville—Making of bricks
1755 G. Frere—Apparatus for fishing
1756 S. A. Hodd and W. Upton—Apparatus for roasting coffee
1757 C. J. Appleby—Locomotive and traction engines
1758 T. C. Craven—Saws for cotton gins
1759 J. H. Johnson—Apparatus for lubricating purposes
1760 F. Fried—Manufacture of artificial wood
1761 W. Staufen—Treatment and application of vegetable fibres
1762 T. Cook—Machinery for uniting together materials employed in the manufacture of boots and shoes

Dated July 3rd, 1866.

1763 G. R. Sheraton—Instrument to be used in cases of difficult parturition
1764 H. Tyerman—Reaping and mowing machines
1765 W. Adkins—Improvements in taps
1766 H. Wootton—Construction and arrangement of self-acting railway signals
1767 W. Adolph—Obtaining motive power by means of steam
1768 A. P. J. Allemand and L. G. Speyser—Machinery for making bricks
1769 G. F. Starnes—Cotton gins

Dated July 4th, 1866.

1770 D. Nichols and W. B. Leachman—Machinery for manufacturing bricks
1771 R. A. Young—Improvements in the busks of stays and corsets
1772 W. McAllum—Manufacture of machine wires
1773 A. Myers—Construction of the fastenings of leggings
1774 J. Clegg and J. Smith—Manufacture of ribbed pile fabrics
1775 T. Sagar and T. Richmond—Looms for weaving
1776 J. Brotherton—Machinery for making the fittings for gas, steam, and water pipes
1777 M. Heury—Improvements in governors
1778 C. Doughty—Apparatus for distilling the grease of cotton

Dated July 5th, 1866.

1779 A. V. Newton—Sewing machinery
1780 W. E. Gedge—Manufacturing a novel sort of bar or rod iron suitable for making horse shoe nails
1781 R. Fowler—Locomotive engines and tenders
1782 H. G. Fairburn—Combining small coal or coal dust into lumps
1783 A. V. Newton—Improved steering apparatus
1784 J. D. Brunton—Apparatus for sinking shafts or pits
1785 A. V. Newton—Construction of connecting links or hooks

Dated July 6th, 1866.

1786 L. Field—Photographic printing frames
1787 W. Chesney—Manufacture of water and steam cocks or stop valves
1788 E. H. Aydon and E. Field—Drawing or exhausting and forcing fluids
1789 J. A. Salmon—Improvements in furnaces
1790 C. Hepstonstall—Looms for weaving stays and other uneven fabrics
1791 J. Monnier, J. Meursut, and C. D'Hondt—Looms for weaving
1792 T. Lishman—Steam boilers

Dated July 7th, 1866.

1793 C. Harvey—Breech loading firearms
1794 R. Kunstmann—Burning and drying bricks
1795 P. Simard—Manufacture of envelopes by the combination of memorandum
1796 A. Clark—Blinds and shutters for screening and closing windows and other openings
1797 J. Murray—Preparation and application of surfaces for disposing and picking up coin
1798 W. Clark—Sewing machines

Dated July 9th, 1866.

1799 T. Ivers and J. Haddock—Construction of shuttle tongues
1800 P. J. Bellot—Improved looking glass press
1801 W. Moseley—Apparatus for slicing and paring cucumbers
1802 J. Elder—Marine steam engines
1803 W. Baines—Telegraph and signal pillars or posts
1804 A. V. Newton—Bobbins used in preparing and spinning machinery
1805 A. V. Newton—Compound for coating ships' bottoms

Dated July 10th, 1866.

1806 J. Millward—Convertible piano and music stool
1807 G. Davies—Necktie or scarf retainer
1808 S. Clark—Arranging and working steam engine valves
1809 J. S. Cuthbert—Painters' easels
1810 W. J. Curtis—Construction of breech loading or repeating firearms
1811 J. Howard and E. T. Bousfield—Construction of steam boilers

Dated July 11th, 1866.

1812 E. McNally—Machinery for grinding and polishing circular saws and other articles
1813 G. W. Hawksley, M. Wild, and J. Astbury—Arrangement of furnace to be applied to steam boilers
1814 W. Walker—Preparing for spinning hemp and other fibrous materials
1815 I. Gregory—Communication by signals between passengers, guards, and drivers of railway trains
1816 G. Haseltine—Improvements in screw bolts
1817 W. Thompson—Apparatus for filling and corking bottles
1818 F. Dégravel—Spring suspension for horses' nosebags
1819 W. Hobbs—Improvements in ordnance
1820 C. E. Austin—Apparatus applicable to sewers and drains
1821 A. V. Newton—Machinery for crimping leather for boot fronts
1822 R. W. Fraser—Modes of obtaining and transmitting motive power
1823 J. N. Fournel—Manufacture of iron and cast iron
1824 W. Naylor—Steam engines
1825 C. W. Farmer, W. E. Partridge, and B. J. P. Webb—Connectors for uniting wires

Dated July 12th, 1866.

1826 J. Moseley—Manufacture of card cloth
1827 W. G. Walker and R. F. Smith—Method of producing illuminating gas
1828 K. H. Cornish—Breech loading firearms
1829 W. Reade—Steam pumps
1830 J. Ward and J. Smales—Machinery for facilitating the adjustment and testing the working parts of locomotive engines
1831 W. Reade—Supplying water to the tanks of locomotive engines and tenders
1832 W. Clark—Improvements in grease cups
1833 D. Gallafent—Transmitting motion to the rudders of ships and other vessels
1834 M. J. Roberts—Cooling worts and other liquids
1835 W. E. Newton—Making covered twist and cord
1836 A. V. Newton—Construction of folding chair

Dated July 13th, 1866.

1837 C. F. Dietrich—Compressing air by means of water
1838 J. Law—Decolorising the products obtained in the distillation of shale, &c.
1839 W. E. Wiley—Improvements in holders for marking materials
1840 A. W. Makinson—Improvements in locomotive engines for enabling them to ascend steep inclines
1841 W. Thompson and T. Stather—Mills for grinding corn and other hard substances
1842 R. Roger—Steam travelling cranes
1843 R. Jobson—Apparatus for holding suspended electric telegraph wires
1844 T. W. Rammell—Improvements in pneumatic railways and in carriages used therein
1845 P. Ellis—Lift hoist or mechanical elevator
1846 A. Prince—Means of preserving timber from decay

Dated July 14th, 1866.

1847 G. Day—Apparatus for stopping or curbing horses
1848 W. Justice—Motive power engines
1849 J. Sampson, C. Sampson, H. Sampson, and R. Burlison—Means for effecting the folding and papering of woven fabrics
1850 L. J. Crossley and J. Sunderland—Preparing and spinning wool and other fibrous substances
1851 J. Ingamells—Machinery for obtaining and applying motive power
1852 W. Ager—Mode of preventing the heating and fouling of guns

Dated July 16th, 1866.

1853 R. Clough and P. Smith—Method of and apparatus for lubricating the spindles of cap spinning and doubling frames
1854 A. R. Stark and J. Woodman—Means of fixing the covers of gas retorts
1855 J. L. Norton and F. L. H. W. Bunger—Apparatus for discharging the water resulting from condensed steam from apparatus where steam is employed
1856 R. Soans—Machines for dressing or for removing dirt and foreign matters from currants and other fruit
1857 T. G. Webb—Manufacture of articles of pressed glass
1858 E. Heusser—Travelling bag
1859 L. Miguot—Preparation of soluble alkaline silicates

Dated July 17th, 1866.

1860 E. Drucker—Fastenings for corsets
1861 W. Thompson—Machinery for mixing and repacking tea
1862 T. Westley and T. R. Beaumont—Improvements in flyers for spinning
1863 J. Richardson and J. Yeomans—Manufacture of hats
1864 A. V. Newton—Spinning yarn
1865 W. B. Sborland—Improvements in handles for actuating locks
1866 W. E. Gedge—Gas burner
1867 C. Varley and S. A. Varley—Electric telegraph apparatus

Dated July 18th, 1866.

1868 G. Plant—Means and apparatus employed in the manufacture of taper or conical and other forms of wrought iron and steel tubes
1869 J. McVitie—Mules for spinning
1870 J. Macintosh and W. Boggett—Manufacturing elastic fabrics
1871 D. Barker—Apparatus for mixing, pressing, and moulding coal and other substances
1872 J. Moffat—Improvements in lamps
1873 W. E. Gedge—Method of instantly releasing or unharnessing one or more horses from carriages of every description
1874 N. Salamon—Sewing machinery
1875 J. J. L. M. Lagarrique and P. A. Castera—Working the points or crossings of railways
1876 F. Tolhausen—Sewing and button hole machines
1877 J. Goad and E. Goad—Mile posts

Dated July 19th, 1866.

1878 J. P. Gillard—Accelerating the generation and transmission of electricity
1879 D. M. Gilbert and L. A. Dubreux—Fastening for letter envelopes
1880 W. Clark—Sewing machines
1881 W. Tongue—Steeping, boiling, bleaching, and dyeing fibrous materials
1882 S. Longbottom and T. Shaw—Machinery for condensing wool or other fibrous substances
1883 A. N. Wornum—Improvements in pianofortes
1884 F. Neidlinger—Sewing machines
1885 R. Irvine and P. Brash—Treatment of certain residues in order to obtain fatty acids therefrom

Dated July 20th, 1866.

1886 W. E. Nathersole—Facilitating the tipping of coal or other material from railway carriages
1887 W. Burgess—Washing, wringing, and mangling
1888 M. A. F. Mennons—Generating gas for lighting, heating, and other purposes
1889 F. J. Rowley—Gas pendants, gasaliers, and gas brackets

Dated July 21st, 1866.

1890 H. Trotman—Feed box for the prevention of injury to marine boilers
1891 H. Smith—Improvements in rivetting
1892 R. Hooper—Improvements in furnaces
1893 W. S. Davis—Construction of a roller for window blinds maps, and almanacks
1894 T. H. Lucas—Machinery for the manufacture of nails
1895 W. Bellamy—Apparatus used for imbibing liquids known as bombillas
1896 G. Canouil—Primings for firearms
1897 G. Canouil and F. A. Blanchon—Firearms
1898 E. Tomlinson—Printing or placing designs on wood for general advertising
1899 A. B. Barou von Rathen and G. H. Ellis—A new mode of constructing a motive power wheel
1900 M. Bayliss—Machinery for the manufacture of bolts and spikes
1901 R. Newton—Means of consuming smoke in the furnaces of steam boilers
1902 J. Saunders and J. Piper—Manufacture of tin and terne plates
1903 R. Mitchell—Shaping and forging metals
1904 J. Morgan—Preserving animal substances

Dated July 23rd, 1866.

1905 J. Leach—Refining paraffin wax
1906 E. Leigh, H. T. Palmer, and W. E. Whitehead—Machinery for cleaning and preparing cotton and other fibrous substances
1907 A. Maguin—Improvements in lamps
1908 A. Kimball—Sewing machines
1909 J. Ramsbottom—Method of using and treating steam for purposes of obtaining motive power
1910 L. L. Sovereign—Implement for beating and cutting meat


MAP OF THE ISLANDS OF GUERNSEY AND JERSEY,
IN PART SHOWING THE VAST SUBSIDING OF LAND
ON THE NORTH AND WEST COAST OF FRANCE.
Longitude 2° W of Greenwich
HURD'S DEEP
Caskets
Burhou
ALDERNEY
Cape la Hague
CHERBOURG
Chole Bank
Estuary
Portrieux
BAY OF ST BRIEUC
St Germain
Port de Dahouet
ST BRIEUC
ALETH AND S. SERVAN
BAY AND SANDS
INUNDATED AND SINCE LAID DRY
NEW CHANNEL
PONTORSON
S. Suliac
DOL
R. Rance
Ru. Couesnon
B R I T A N N Y
Corseul
Roman Road
Dinan
NŒODUNUM
A U L E R C I D I A B O L I T Æ

THE ARTIZAN.

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1st SEPTEMBER, 1866.

ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 180.)

Farther reasons for believing that Jersey was, since Ptolemy's time, an integral part of the Continent.

50. The following is an extract from Mr. Poingdestre's MS., commencing at folio 36. He says, speaking of the Channel Islands:—

"Not much knowledge of them can be expected before the conquest, seeing there is so little preserved since. Except the Records in the Tower and at Westminster, there is hardly anything reliable. This darkness has deterred others but it has instigated me to farther research especially in MSS. of the lives of the Saints, which amongst many fabulous things, contaeine many truths."

I hope in due time to convince the reader that a good deal about the Channel Islands (though they are not referred to by their names) may be gleaned from ancient Classical authors. The following is not a copy, but an abstract with quotations, in continuation of the second part of Mr. Poingdestre's MS.

51. He has first tried to ascertain the old names of the islands. For "of what use," says he, "would it be to know the feates of Cæsar in Gallia, if I did not know that Gallia means France?" He supposes "Cambden is the first who wrote that Jersey is an island in ye. British Ocean, which in Antoninus' Itinerary is called Cæsarea and that Jersey or Gersey is but a contraction of that name as Cherbourg or Gerbourg is of Cæsaris Burgum; a very good example, if Burgum or Burgus were a Latin word near Cæsar's time. His [Camden's] conjecture has been followed by all others, and I do not intend to oppose it. I wonder, however, that not long after Antoninus it should be called by the name of Augia which can in no way have been derived from Cæsarea." We learn the former name from a donation of four of these islands to Sampson, Bishop of Dol, in which this pretended Cæsarea is called Augia and in French Angie. "This donation is found in the life of that Bishop which I have seen in written hand very ancient, and in Latin; and is attested by Bertrand D'Argentre in his History." If it be doubted that this Augia is Jersey, Mr. Poingdestre says he will remove that doubt by a fragment taken out of the Abbey of Fontenelles by Du Chesne in his third volume of *Scriptores Coætanei Hist. Franc.* "neere as ancient as Charlemagne* concerning Geroaldus one of the abbots there. Is enim (sayth he) quadam legatione fungebatur iussu Caroli Augusti, in Insulam cui nomen est Augia, & est adjacens pago Constantino. If he had pointed at Jersey with the finger he could not have shewed it more plainly: for Gregorius Turon: Aimoinus and Papirius Masson, speaking of Jersey without naming it, call it, the first Insulam maris quod adjacet Civitati Constantinæ, the second Insulam maris quæ adjacet Constantiæ, and the third Insulam Constantiui littoris. No other island than Jersey can be meant. Guernezey "is out of the way: Chausey† (which is the likelyest next to Jersey) is an inconsiderable plot of earth or rocks rather, unsuitable to such an employment as is spoken of in that Fragment, and not so much adjacent to Coutance as to Aurenches on the coast Britany:"* and Alderney is farther off: much less he thinks can Serc be meant, for Jersey lies between it and Coutances. Paulus Æmylius, he says, is mistaken in calling it Insulam Constantiensis Diæcesis: for at the time of which he speaks it was not part of the Diocese of Coutances, but of that of Dol. "This name hath had many synonyms in ye. world, from Homer's time (in whose workes we find Augeia eratiene) downewards, and in our time both upon the lake of Constance, where are two small islands of that name, and in Normandy itself Le pays d'Auge, called by Cenalis, Normannia Augiaca, that is (sayth he elsewhere) Coele† Normannia, Normandy the hollowe, for Auge in old French signifieth a Trough or other such hollow thing, and for that reason this name may possibly have been anciently given to this Island, because of the many great Valleyes which are to be seene there from one end to the other."

52. I interrupt the abstract and quotations from Mr. Poingdestre to remark that the trough, or hollow, may, and probably did, signify the depression now occupied by the sea between Jersey and Normandy. Cenalis is speaking of *Normandy*, not Jersey; and the only *considerable* hollow anywhere near Jersey in that province is the one in question between Jersey and Normandy. Cenalis clearly could not have meant the *very small* (not "great") valleys through which the Jersey brooks run, when he spoke of "Normandy" the hollow. I cannot agree with Mr. Poingdestre either in the following passage, where he thinks that Jersey was called Augia *before* and *during the time of the Romans having to do in these parts*, for reasons which will be stated after concluding the abstract and quotations from his MS. He says:—"I am apt to beleeve that Augia was the true genuine name of this island, and that long before ye Romans had anything to doe in those parts, and that it was continued among ye natives all along the Romans' time; and after theire departure untill the Norman Dukes that the Roman name was received, but with a corrupt way of pronouncing it" as Gersui, Gersoi, and by Vaicce in his verses written in the time of Henry II. "Gersui," also Gressui, Gresoi. Matthew Paris calls it Gersea, and a MS. chron. in the library at Oxon, Gerzy. In the Tower and Westminster records it is "Jereseye." which he thinks is in imitation of the Saxons, and gives several illustrations.

53. Wace the poet was born in Jersey at the commencement of the twelfth century, and died in England about 1180. He says that the celebrated Danish chief, Hasting, landed

"En Auremen, en Guernesi.
En Saire, en Erin, en Gersi."

Hasting's landing was in 838 according to one authority, and in 856 according to another. But Wace calls the islands by the names of his own period, which might, or might not, be the names current in Hasting's time.

54. It is not a little significant that during a certain period which terminated legally but not popularly, at the middle of the sixth century, Jersey is described as "an island of the shore of Coutances" as if it had *no name*. It cannot but be regarded as surprising, and as a fact which requires to be accounted for, that an island which even yet contains about

* Crowned A.D. 800, died 814.

† A very large proportion of each of the three extensive groups of rocks called respectively Chausey, Minquiers, and Grelets; is within reach of high tides and is consequently entirely destitute of earth.

* I am under the necessity of differing from Mr. Poingdestre here. The centre of Chausey rocks is five miles nearer to Coutances than to Avranches, and both Coutances and Avranches are in *Normandy*.

† This is evidently meant for the Greek word Koile (feminine of Koilos) *hollow*. Exactly for the same reason a part of Syria is called *Cœle Syria*, namely because of the immense "hollow" of the Dead Sea, which is more than 1,200 feet below the Mediterranean.


Plate 104
MAP OF THE ISLANDS OF GUERNSEY AND JERSEY,
IN PART SHOWING THE VAST SUBSIDING OF LAND
ON THE NORTH AND WEST COAST OF FRANCE.
HURD'S DEEP
ALDERNEY
Caskets
Cape la Hague
CHERBOURG
GUERNSEY
SERC
GREAT RUSSEL
Jethou
Hanois
Lihou
Trois Grunes
VALOGNES
NORMANDY
Estuary
Trois Grunes
MOUTH OF R. OLINA
DIR-OU-ILLES
ECRE HOUS
Oyster Boundary
JERSEY
St Owens Bay
Grouville Bay
LESSAY
HARBOUR OF THE CROTIATONI
Line of Shallowest water
MOUTH OF RIVER TETUS
COUTANCES
North Latitude
Minquiers
Grune Norman
Grunes du Sud
Coast line in AD 709
Chausey
GRANVILLE
MOUTH OF RIVER ARGENIS
FOREST OF SISSY
STALIOCANUS PORTUS
BAY OF ST BRIEUC
Cape Frehel
ST MALO
LETH AND S. SERVAN
BAY AND SANDS OF MONT ST MICHEL
MONT ST MICHEL
AVRANCHES
INUNDATED AND SINCE LAID DRY
DOL
PONTORSON
ST BRIEUC
BRITANNY
Roman Road
AULERCI DIABOLITÆ
Dinan
NŒODUNUM

sequently entirely destitute of earth.

diterranean.

47 square miles after beavy losses of territory, should have been *nameless*. Childebert, King of France, about the year 550, gave to Sampson, Archbishop of Dol "certain islands and lands in Normandy, de Rimoul, Augic, Sargic, and Vesargic, which are islands on the coast, for I have seen it" D'Argentre says "in ancient letters."* These islands no doubt were *Rimoul* Alderney, *Augic*, Jersey, *Sargic* Sercq, and *Vesargic* Guernsey. Alderney is still called "remui" in Andrea Biancos' Chart, found by Mr. Rawdon Brown among the Venetian State papers, date 1436, but supposed to be still older. Bianco gives rocha toba for Jersey, quasquit for the Caskets, and cabo de g (the g having an abbreviation over it) which doubtless means "the cape of Guernsey," as it is written against tbe S.W. angle of that island. Tbe map comprises all the north of Europe, and is of the scale of 100 miles to au inch. Neither this Chart, nor Blaews' "Sea-Mirrour" date 1625, nor Dumaresqs' map of Jersey 1694; can be relied on as hydrographically correct. The latter exhibits a remarkable promontory at the S.E. angle of Jersey, three miles long, by a quarter of a mile wide, unlike anytbing now existing. The map of Jersey in Camden's Britannia, exhibits the same promontory, but only a mile and a half long, which however the text does not explain. I think the promontory only means part of the Banc du Viellet.

M. de Gerville supposes tbat the names Augia, Angia, Agna, Angey, Aucey, and Agen, signify along with Gersey, or Gery, a habitation by the water. And tbat Cæsarea is an origin derived from flattery.

It is well known that in Celtic, *Ey* signifies an island, and *An* signifies water. May we not conclude tbat the Romans were obliged to give the island a name, that it might be inserted in their Itinerary, and that they appropriately called it after their great general and first emperor, who had so mucb distinguished himself in the neighbourhood? And that this must have happened at some period between the middle of the second century (Ptolemy's time), and the abandoning of Armorica or Britanny by the Romans in 409;† they would bave no occasion to trouble themselves to name the island *after* they had abandoned the neighbourhood? The Gauls would have no occasion to name the island until King Childebert gave it to Sampson, when doubtless the necessity was felt of giving it a name.

55. *Neustria Pia*, or Pious Normandy, by the Abbé du Monstier, 1663, is called in Watts's *Bibliographical Dictionary* "an important and valuable work, similar in its plan to Dugdale's Monasticon." At p. 155 I find the passage quoted by Poingdestre (Art 51) "For the abbot [St. Geruoldus] by command of Charles Agustus [father of Charlemagne] discharged a certain embassy in an island of which the name is Augia, which a race of Britons (Brittonum) inhabits, and is near the town of Coutances, over which at that time a certain person of the name of Amvvarith was general' (Dux), &c. It is stated also in Neustria Pia, p. 154 that Geruoldus died on the Kaleuds of July iu the year of Christ 806. And that bis embassy to Augia was in 787. And Falle tbe historian of Jersey, is also of the opinion that Jersey is meant by the passage, which he quotes from *Hist. Franc.*, Lib. 3, cap. 26, (the date must have been about 574) "a certain island of the sea wbich is adjacent to tbe city of Coutances." If Augia did not mean Jersey, that considerable island would still have been without a name, which is incredible. Yet we shall find some confusion in the passage next following (wbich is translated from Neustria Pia), between Sciscy or Chausey, and Jersey. For he speaks of "Sisciacum" and "Gerzay," as if they were the same island, which is of course a mistake.

56. *Confusion between Sciscy or Chausey, and Jersey,* "*Scisciacum.*" "Thither afterwards S. Pretextatus 17th Archbishop of Rouen was banished by command of King Cbilperic, at the instance of Queen Fredegunda: he is driven out into exile‡ into an island of the sea (writes Gregory of Tours) which is adjacent to the city [civitati] of Coutances. But that island was called Brenciana, commonly Brency;§ situated in the Ocean sea near tbe shore of the city [civitatis] of Coutances, iu Lower Normandy, if we believe Tillius.* But in the antiquities of tbe MSS. of Normandy, it is named Gergia, or Gersayum, and *Sisciacum*, in French *Gerzay* and Chezay; according to Cænalis, in [reference] to the same Prætextatus.† It was afterwards inhabited by Franciscan brothers, but tbence by heretics, being profligates they were compelled to settle tbemselves out of sight near Macropolis; the aforesaid bishop Cænalis thought, and more rightly, that it was some island. [and] was that, where in those ancient times the noble monastery, Sciscy, of S. Paterne stood, now altogether overthrown and levelled." *Neustria Pia*, p. 67.

57. In the life of S. Sampson,‡ we read the followiug curious passage. The Chronicler says, "a certain island *lately* established" (insula quædam nuper fundata), as if he meant that it had lately become an island. The context, however, is unfavourable to this interpretatton, how could Pyrus, or any other man, establish or make an island so large? May not the sentence rather mean, that Pyrus established in, or endowed the island with, some religious bouse? "But there was not far from this monastery a certain island lately established by a certain excellent man and holy Presbyter Pyrus by name, in which island also I have been, with whom, I say, Sampson wished to live."

58. Aimoin, the monk of S. Germain,§ also says (p. 183) "Prætextatus, Bishop of Rouen, is accused" (and at p. 190) . . . "he is banished into exile in a certain island of the sea which is near tbe city (civitati) of Coutances." In the annals of Massonius, p. 55, "He is banished into an island of the shore of Coutances." In Robert Gaguin's *Hist. Franc.*, fol. xxii B, "and thus Prætextatus is banished by design. Wbom when seized the king commands to be kept in prison. From whence when freed he almost escaped by night; troubled by abuse and wounds they at length banish him in an island of the diocese of Coutances."

In all this there is nothing in favour of Chausey being the island meant, except that it is about, only half as far from Coutances, as Jersey is. Jersey may, without doing any violence to language, be termed "an island of the shore of Coutauces." We find as follows in Steeven's supplement to Dugdale's Monasticon:—"Bernard d'Abbeville, to avoid being chosen Prior of St. Cyprian's, proceeded to the borders of Britanny, into the *peninsula* of Chaussey, on the nortb side of that province."

I think Jersey must have been meant, botb because Chausey was a peninsula (not an island), and for several other reasons. Tbose reasons are as follows:—*First*, in Art. 54 Augia *must* mean Jersey, in the enumeration of the islands given to Sampson. And Augia is identified (Art. 55) as the island "near the town of Coutances," to which Charlemagne's father sent an ambassador. *Second*, as Poingdestre well observes (Art. 51) "Chausey, which is the likeliest next to Jersey, is an inconsiderable plot of earth," for a great prince to have sent an ambassador to; it is much more probable tbat the embassy was to Jersey. *Third*, if Augia does not mean Jersey, Jersey was *ignored* as well as nameless, which is incredible.

59. Tbe important poiut to be gatbered from all tbis discussion is that Jersey must have been the islaud meant by the description that it was near the city (or shore) of Coutances. *as if it had no name*, which is a very improbable circumstance, *if* it had been an island from time imme-

* *Hist. Bret*, folio 114 B.

† Gibbon, Vol. 5, p. 346.—Nennius gives a different date as will be seen hereafter.

‡ "Lib. 1, Histor. Franc. cap. 18."

§ The origin of this word signifies an *excretion* or *remnant*; a very approprpriate name, which ever of the two islands it is applied to. By the kindness of Frederick Crank, Esq., I am enabled to quote a ease in Persia, observed in 1836, between Shiraz and Ispahan; where part of the plain Yezd-de-Kost, three to four hundred yards in breadth and many miles in length, has sunk to the depth of from sixteen to twenty yards—and where large masses of roek still rest on each other in the most fantastic and apparently precarious positions. Close adjoining is a fort hearing a similar eurious uame, *i.e.*, Pok-yu-Kollah, or "exerement fort;" the inhabitants of Teherant informed him, that discharges of gas or steam took place from the eavities under the fort, whilst the earthquake was in operation. The banks of the Roymungal, one of the largest rivers of the Soonderbuns in the south of Bengal, within his own ohservation, "have risen eonsiderably." And "in many parts of these rivers at low water, the traees of the brick foundations of buildings are plainly discernible; and in the Chattiya river which hranehes out of the Thakoorannee, a very old brick tower of 90 or 100ft. in height, still stands." It is to he hoped that Mr. Crank will very soon earry into execution his plan of writing out a full account of these interesting plaees, illustrated by plenty of his beautiful pen and ink sketehes.

* "Tillius in Chronieo de Regib. Franc. ad ann. 582." See also Neustria Pia, p. 712.

† "Tom. 3. Hierachiæ Eccles. Neustriæ MS."

‡ *Vita S. Samsonis act. SS. Bened.* Sæc. 1, p. 171.

§ Aimoini Monachi, *Hist. Franc.*, Paris, 1567. Morey's Dictionary says that this History was written by another Aimoin, a monk, of Fleuri, in the 10th century.

morial. To recapitulate. The Romans were obliged to give it a name to insert in their Itinerary, and they very appropriately called it Cæsarea. King Childebert was also obliged to name it when he gave it to Sampson in 550, and he called it Augia. A certain amount of sinking must therefore have occurred at the east of present Jersey, in order to have entitled it to a name *Augia* derived from *Auge*, "a trough, or hollow." About the same date, namely, in 582, Jersey was called Brenciana, or Brency, which signify "a remnant." But Gregory of Tours who was then living (for he was born about 544, and died in 595) *did not know it by any name*, for he of course was not consulted about a gift of certain distant islands to a neighbouring archbishop. The transaction no way concerned him, and he had evidently never heard by what name Childebert conveyed Augia to Sampson. All which tends to prove, and Ptolemy's positions of the mouths of the rivers Argenis and Tetus completely prove, I submit, that *Jersey had only lately become an Island*. The "line of shallowest soundings" on the map, must therefore have been a *watershed* previous to the separation of Jersey from the Continent. And it may be quite true (though I accept no responsibility in the way of guaranteeing it) that the diocesan in his journeys to and fro between Coutances and Jersey—could cross by a plank, the small brook which may have been the only intervening water between Jersey and Coutances. If that was so the *final* sinking must have taken place since the year 1000; for we find that the Channel Islands were transferred from the diocese of Dol to that of Coutances "by one of Rollo's immediate successors, apparently Duke Richard II. or III.," who ascended the throne respectively in the years 996 and 1026.*

CHAPTER V.

CHANGES IN THE BAY OF MONT S. MICHEL, AND NEAR S. MALO.

60. Abbé Desroches published his *Hist. Du Mont S. Michel* "aprés les chartes, cartulaires, et manuscrits, trouvés au du Mont S. Michel, à la Tour de Londres, et dans les Bibliothéques de la France et de l'Etranger," in 2 vols. 8vo. Caen, 1838.† In Vol. 1 p. 4, he says:—

"Anciennement les iles de Jersey, de Guernsey et d'Aurigny tenaient à la terre ferme: c'est sentiment des savans." In a future chapter when Cæsar and Diodorues are treated of, reasons will be submitted for believing that all was *dry at low water in their time*, from Guernsey and Alderney to the continent. Passing over two unimportant sentences we come to the following paragraph, in which he attempts to prove that in the Celtic language both the words Neustrie (Normaudy) and Vestrie (Brittanny) signify that the two provinces had been separated from each other by some convulsion of nature. As the present writer is not skilled in Celtic, the passage is simply quoted for the reader's own judgment. Abbé Desroches says:—"Une preuve que la Neustrie fut separée de la Bretagne, dans les temps les plus reculés, ou du moins qu'on l'a cru, c'est que ce changement a ete désigné en langue Celtique. Le nom de Neustrie est formé du Celtique *an ev ze tre* ou *ter.* le gué ou la rupture faite par les eaux, causée par l'extension de l'Ocean Brittannique, sur les terres de la baie où sont d'un côté le Mont St. Michel, et à l'opposite les cótés du Cotentin et de l'Avranchin.‡ Le mot Vestrie est le même que *ev ze ter*, rupture faite par les eaux."

Note. I find these last two sentences, nearly word for word the same, in *Essai sur l'Hist. de Neustrie.* Anonymous, Paris 1789, 12 mo. 1st Vol. p. 3.

The Abbé refers his readers to "M. le Brigant de Quimper."

61. He says, speaking of Genets, now an inconsiderable village near the sea, five miles west of Avranches:—"Cette ville posseda plusieurs églises. Celles de St. Sebastien et de Ste. Catherine *ont été submergées*; il subsiste encore des ruines de celles de Ste Anne et de Brion sous l'invocation de Ste. Laurent." And he thinks that the ancient city Dariorigum was not Vannes on the west of Britanny (nor anywhere near it), but was Vains two miles west of Avranches, and that Cæsar's sea-fight with the Veneti took place in the Bay of Mont S. Michel. For many reasons, as will hereafter appear, I am of a different opinion.

62. The late Abbé Manet published at S. Malo in 1829 a small 8vo. volume of 183 pages, entitled *De l'etat ancien et de l'etat actuel de la Baie du Mont S. Michel et de Cancale*, &c. This work he informs us "was crowned and honoured by a gold medal with 400 francs by the Royal and Geographical Society of France, at its solemn assembly of the 28th of March, 1828." Abbé Manet certainly rendered great service to science, by collecting and narrating as a Historian, many important physical facts. He appears to have had no thought what was really the cause of the sea's overwhelming the forest of Sciscy, on the occasion of an equinoctial spring tide propelled by a strong north wind. And especially he assigns no reason why the water did no ebb off again. Nor why that which was the Forest of Sciscy until the year 709, has been navigable sea ever since. It may be that the weight of the vast mass of water brought upon the country (now submerged) on that memorable occasion, was the proverbial last feather's weight which broke the camel's back, and caused the land to settle down into some cavity beneath: especially as a diligent search in the works of chroniclers and historians has entirely failed to discover any reason for believing that there was an earthquake shock. Some think Manet has been too credulous. Partly to satisfy himself on that point, but chiefly to obtain what other evidence he could, the present writer devoted a month's hard work at the British Museum reading room, in July and August 1861, in searching and making extracts, and had a fair measure of success. Of sixteen authorities quoted by the Abbé in his Note 26, to prove the former existence of a Forest called Sciscy in the Bay of Mont S. Michel; about one half of those references have been examined and verified by the present writer. The particulars gathered are about to be laid before the reader, from time to time.

63. Abbé Manet says that the former existence of the Forest of Scisey, or Chausey, is a fact of which history does not permit us to entertain the least doubt. And indeed if history is worth anything, there can be no doubt whatever that this forest once existed, and that an immense tract of it has been for about eleven centuries and a half under water, at every high water. He says (and he is justified by several chroniclers who wrote previous to the tenth century, in saying so), that the Bay of Mont S. Michel did not exist as a bay until A.D. 709. He says also that there have been [at least] five distinct catastrophes of permanent submersions of land. Namely, in the sixth century, the seventh century, 709, 811, 842,* and 891; and a seventh appears to have occurred in 1163. According to a pamphlet published in 1860, entitled "Essai Géologique sur le Département de la Marche," par M. Bonissent, member of the Societé Géologique de France, a reference is given to the twenty-first volume of Dom Bouquets' "Historians of France," that about the year 1244, a formidable tide inundated our shore anew, and extended as much 24 kilometres, or about 15 English miles over the land, and so completed the destruction which began in 709, being an eighth sinking. Mr. Metivier says a ninth submersion "is mentioned by our countryman Dumaresq, in 1247, there was likewise an earthquake.† A tenth, as we have seen, occurred around Jersey in 1356. Of the date of the submersion west of Guernsey there appears to be no record. And an eleventh submersion took place on the north of S. Malo about 1437; since which date apparently all has been stationary, except on the west of Britanny, where a twelfth sinking took place so lately as 1827.—*See Manet, p. 76, foot note.*

64. Of all these, that of 709 appears to have been by far the greatest in its extent; of the effects of previous "inundations" there appears to be no record. Abbé Manet describes the inundation of 709 as having been unhappily sustained by a terrible north wind: another writer says the direction of the wind was different. The invasions commenced at S. Pair,

* See Tupper's *History of Guernsey*, p. 31, 34.
† 575g 28, *Brit. Mus.*
‡ The Cotentin extends from Cape la Hague to some point between Coutances and Avranches, and the Avranchin extends from that point to Pontorson.

* The chronicler of Fontenelle was a witness that from the 22nd to 29th Oct., 842, the islands were visited by a violent earthquake and rumblings, which engulphed the sea-shore of the Cotentin, or that part of Normandy which is in the diocese of Coutances.—Tupper's *Hist. Guernsey*, p. 28.
† There was an earthquake Feb. 13th, 1247, in London, in diocese of Bath and Wells, also felt in Piedmont, Savoy, and Syria.—See Dr. Mallet's "Earthquake Report," vol. xxii., Brit. Ass.

he Abbé says, which is a small village about two English miles south o Granville. "The environs of Chausey first yielded to its attack, and the tempests continuing to unite their fury to the efforts of the subsequent tides, produced at last the most frightful changes. *All disappeared under the waters, with the exception of the mountains which form the islands.** and a portion of the forest intermingled with meadows, which was spared for a time on the coast of Avranchin." * * * "The storm changed the course of the Couësnon and gave to the ocean nearly all the portion of the bay which belongs to Normandy."—*Manet, p.* 11.

It destroyed all the land to a point distant three English miles westward of Cape Lihou, near Granville; as well as the land enclosed by an imaginary, nearly straight line, drawn from the said point to the promontory of Caucalle. This boundary line on the map is copied from one of Manet's maps. But the ravages of the sea in 709, were not confined to this. It began again, he says, in "le Verger" in the Commune of Cancalle and destroyed all the land between the present coast and the line on the map *marked coast line in A.D.* 709, extending from le Verger to Cape Frehel, being 21 miles in length and often as much as 2 miles wide. The submerged part first mentioned averages about 18 miles long by 9 miles wide, so that in the whole there was a loss of about 200 square miles, in the districts named. Beyond Cape Frehel, Manet says, he has no attention to follow it. Not quite the whole of the land in question was destroyed in 709, the isle of Cesembre was still joined to the continent in 1108, and a tract of meadows extending from S. Malo to Cesembre, 2½ miles in length and called the meadows of Cesembre, was part of it covered by the sea in a moment in 1163,† but the whole was not finally lost until about 1437, which is the date of the last account we have of it. Abbé Manet's description has enabled the writer to describe these meadows on the chart.

65. The island la Catis, 10 nautical miles north-west of S. Malo, was formerly surrounded by a forest which the River Rauce passed through. And there was formerly in the sea to the westward of Lannion (which town is 67 miles westward of S. Malo) "an ancient spacious forest." And as we shall find presently, a vast quantity of trees was washed up on the coast of Morlaix in 1812. These were probably some of the last named forest.

66. Abbé Manet says, p. 12, the sea in 709 swallowed up "all the flat country which was in view of the town of Aleth.‡ We are certain the disaster there was considerably greater, since this territory was much more populous than the other. Its devastations commenced at Cape Frehel, which disappeared in a moment. The assault of the waves carried away also at the same instant all the space occupied by the shores of S. Jacut. It made breaches in five or six places in the long chain of rocks, which exist from the east of Cesembre to the point of Mingar in S. Coulomb,§ and gave passage to the torrent. At last the lands which joined the two arms of the River Rauce were overwhelmed in their turn, and the new deluge rapidly gained an entrance to what is now the harbour of S. Malo, and of which this town, as well as that of St. Servan, form the two sides, one on the north and the other on the south. It formed there a separation of about 600 toises ‖ in its least extent—that is to say from the south part of the rock of Aarou ¶ to the opposite point which we now call Nais, or Naye. It spread itself afterward on one side into the meadows called la Hoguette and des Joncs which border the high road leading from la Hoguette to Paramé, and on the other side into all that extent which we now call Marais Rabot, Little and Great Marshes, &c. It extended even to the heights of Paramé, Tertre, au Merle or mountain of St. Joseph, la Grand Rivière, and even Frotu and du Vallion, as you go to Château-Malo, and Saint-Meloir. The Rauce which was only a large stream from Aleth to Dinau, acquired by the same event, a considerable breadth and depth to above S. Suliac, a town about mid-distance between those two places.* The district he describes (exclusive of the part between Aleth and S. Suliac) extends to about 5 miles east of S. Malo by perhaps half as much in breadth.

67. Is not this remarkable swallowing up, devastating, disappearing in a moment, carrying away at the same instant, making five or six breaches in a chain of rocks, and so giving passage to the torrent: just such a description as a faithful chronicler might be expected to give, if the ground was sinking and he did not know it?

68. At p. 11, 12, the Abbé says:—"The storm changed the course of the Couësnon, and gave to the ocean nearly all the portion of the bay which belongs to Normandy.† It gained the whole of the parishes of St Benoit-des-Ondes and la Fresnaye, even to the marshes of Dol, which it succeeded in completely destroying in 811 at the approach of autumn; it desolated and destroyed the parishes of Cherueix, S. Broladre, S. Marcan, Ros-sur-Couësnon, and S. Georges-de-Grehaigne. In the meantime it respected still at these two epochs (709 and 811) different portions of territory which it has swallowed up since, and which we shall recite in note 51." In note 51 he states as follows:—"Beyond, the environs of the Herpins and the Fillettes have ceased to exist, having been undermined in their turn; the sea spared then as we have already said, the little village of Porz-Pican, and a certain extent of neighbouring territory, which are no more to be found. The principal parishes which from this time have successively paid tribute to its rage are those of S. Louis, Mauny, and la Feillette, which still existed at the commencement of the 13th century, as is attested by different donations of land situated on their borders, to the Abbey of Vieux-Ville in Epiniac, and by the Synodical books of the Bishopric of Dol, which have continued to mention the names until 1664."

69. Thus the sea overwhelmed about ten parishes (some of which have been recovered by embanking) and we shall have accounts of the loss of several more presently. It inundated all the tract of land from the Bay of Mont S. Michel nearly to Dol, comprising 26,000 acres,‡ or nearly forty square miles in extent. Sir John Herschel ("Outlines of Astronomy"), 1864, p. 816), gives the toise as 6·394593 British feet, which would give only 24,751 acres, which are equal to about 38⅔ square miles. Manet says in his note, that the embankment by which this vast tract has been recovered was first commenced in 1024. The tract can be seen on the map. It is mentioned in Trollope's "Summer in Britanny, p. 187, that the embankment is sixteen miles in length. Abbé Manet says six leagues and that it was not all constructed at once.

70. In his vol. ii., p. 103, &c., Mr. Trollope, who was a diligent collector of old Breton legends, mentions the ancient cities of Lexobia, Ys, Tolente, and Occismor "of which the mere names survive." Their sites are doubtful, and a fruitful subject of dispute to the Breton antiquaries. He mentions also, p. 118, that in the extensive sands of S. Michel—not Mont S. Michel—but near Laumeur on the north of the department Finisterre, "once existed, according to the local traditions, a flourishing town called Kerfeunteun, or the town of the fountain." He says, p. 358, that constant and immemorial tradition has fixed the site of the city of Is, or Ys, "in the immediate neighbourhood of the Pointe du Raz." More as to this alleged city in a future chapter.

71. The lost territory described in Art. 64 previous, as well as the 40 square miles mentioned in Art. 69, were covered, Manet says, with a thick and sombre forest, namely, *the forest of Scisey*. It has been mentioned, he proceeds, by Latin authors as *Scisciacum nemus*, in French, Scisey, now changed into Chausey.

71*a*. I have had doubts about re-publishing the following legend which

* The italics are the present writer's. the passage gives direct, though unconscious, testimony that the ground had sunk.

† August 2, 1163, an earthquake is recorded, but it was in Anjou. See *Chroniques de Saumur et d'Augers; Dom Bouquet*, t. 12, p. 482; *Marténe et Duraud*, t. 5, p. 1145; *Labbe*, t. 1, p. 279. In my MS. Appendix is an account of all earthquakes at all likely to have operated on the French coasts.

‡ The cite part of S. Servan.

§ Four miles west of the Point of Cancalle.

‖ 640 yards.

¶ On which S. Malo stands.

* These places are all between the River Rauce and the Bay of Mont S. Michel, but the scale of the map is too small to admit of their respective situations being exhibited.

† The places about to be named by him are all comprised in the Bay of Mont S. Michel and in the tract inundated.

‡ "20,599 journaux et 13 cordes submersibles (le journal de 1280 toises carées)."—See "Manet, p. 99.

occurs at p. 159 of Dr. Hairby's Book, and it has in fact been added to an otherwise completed section of the MS. The principle of altering nothing, and suppressing nothing, settled the question in the affirmative. Passing over all about S. Michael, Satan, and the angels, the rest is very like a graphic description of what the action of the sea must necessarily have been when the ground was sinking.

Legend of Mont S. Michel, A.D. 709. "St. Michael unable to banish Satan from the world, wished to place the sea between him and the two rocks,* and for this purpose he ordered it to approach and surround them with its waters. The mandate was not immediately obeyed, but from that moment fearful signs appeared in the air; globes of fire rushed through the dark shades of night; groanings and lamentations which seemed to come from the bowels of the earth, were heard; the wind howled through the forest trees: the rains fell and all nature seemed to wait some great crisis. These alarming prognostications continued till the month of March; when the rivers Selune, Sée and Couësnon simultaneously overflowed their willow-bordered banks, carrying shepherds, herds, and people with them into the sea. The ocean sympathised, driven by a boisterous north-east wind, it burst through its banks and forced a way into the hollows, uprooted the forest, levelled the surface, filled the vallies, created new land, defaced the old, rose like a water spout in one place, and glided along the earth like a serpent in another, *the angels pushing it forward with their hands* [!]. It mounted, it reared like a horse under the lash of the whip, its white main floated in the air as high as the clouds. Thr two Mounts were not protected from its wrath. The waves clung to their sides as the wasp does to the flowering almond: the waters stripped them of their verdure, of their fresh covering of broom, mingled with white roses, tore from their heads their plumes of vervain, they ate the flesh to the bone. And when peace was again restored to the country, when the calm—the first fruit of the tempest—shone forth in a brilliant day, nothing was to be seen but a vast sea, in the midst of which were two black and naked rocks, such as one of them now is, and the other would be if without its mural dress."

(To be continued.)

* Namely Mont S. Michel and Mont Tombelene.

THE PAST AND PRESENT PRODUCTIVE POWER OF COTTON MACHINERY.

(*Continued from page* 176.)

Part III.—*Modern History.*—(Continued).

The picking motion was worked at the top part of the loom, from the tappet wheel, by a bowl coming in contact with a lever at every revolution of the wheel, the picking stick being connected with the lever by a strap round the end. The taking up of the cloth in this loom was dependent upon the weight put upon the warp beam (similar to hand looms); this was left to the weaver to regulate according to the picks required. The weaver must, consequently, always be in attendance to pass round the loom to see if the right quantity of picks were being put in; this, of course, took much time, and prevented one weaver from minding more than two looms. The kind of temple used in 1830 was of wood, flat, and hinged in the centre, with a button which kept the hinge locked while the loom was at work. The length of the temple was the breadth of the cloth, and a series of small spikes or needles at either end caught in the selvage of the cloth, and thus kept the web at the proper width. The shifting of the temple was a great hindrance to the weaver, as it had to be repeated every few minutes. The greatest speed at which this loom could be worked was from 80 to 100 picks per minute, consequently the production was about one-third that of our present power loom.

The first improvements made in the loom of 1830 was in temples, by Mr. James Smith, of Deanston; they were set at a slight angle, in a direction outwards from the fabric, so as to give them a better hold of the selvage; dated about 1837 or 1838, it consisted of a piece of brass or iron about the size of a penny piece, and in the same form, with spikes or needles; the name given to these was the penny temple.

The second and most important improvement was made by Messrs. Kenworthy and Bullough, of Blackburn, about 1841—and which has never yet been surpassed—by inventing a positive taking-up motion, to roll the cloth up, as it received the quantity of picks. In this motion, change wheels are made use of, which secures with the greatest nicety that any given number of picks shall be put in each inch of cloth. And this it secures with a mechanical accuracy which is in no way dependent on the weaver, who, either for the purpose of getting more cloth, or from carelessness, might vary the number of shots per inch, and so produce a fabric which would be unsaleable on account of their regularity of the texture. Closely connected with the taking-up motion is the letting-back motion, a simple expedient by which the web can be let back any number of picks which the loom may have worked after the breakage of the weft shots, that the beating up of the slay may be resumed at the exact spot at which it left off when the weft broke, and so the unseemly blemish of "gaws" in the cloth may be prevented.

The third improvement was made in the temple by Messrs. Kenworthy and Bullough, of Blackburn, in 1841, by inventing the "roller temple." This contrivance was a small roller covered with find sand, emery, or other rough surface, revolving in a semicircular trough or casing; the cloth passing under the roller, and between it and the casing, was transmitted of a parallel and uniform breadth to the cloth beam.

Another improvement was effected on this roller in 1842, by Mr. John Railton, of Blackburn. In this improved temple, two or more rollers or bars are used, which are chased with a screw thread—one half right handed and the other left handed, and also fluted, so as to present "a continuous surface of small points or pins;" the cloth being led over one roller and under the other, is kept distended tightly, and transmitted over the breast beam to the taking-roller.

Another temple, combining the features of Mr. James Smith's and Messrs. Kenworthy and Bullough's patents, was invented by Messrs. John Elce and Co., of Manchester, and John Bond, of Burnley. In this invention, "two or more rollers" are used, as in Messrs. Kenworthy and Bullough's, and they are covered with "rowels," and provided with guards and shells, so shaped "that the fabric to be distended in the loom is carried about half round each of the rollers." But the temple which has stood the experience best, and is now in most general use, is the "trough and roller temple" of Messrs. Kenworthy and Bullough.

A fourth improvement was made by Messrs. Kenworth and Bullough, of Blackburn, in 1841, by inventing a motion called the weft stopping motion. The motion is so arranged that ou the breakage or absence of the weft thread it instantaneously stops the loom by throwing the driving belt on the loose pulley and by applying a brake instantaneously stopping the loom.

The next improvement is another invention by Mr. James Bullough, in 1842, for the prevention of damage to the yarn, and to stop the loom when the shuttle is caught in the shed, called the "loose reed," a contrivance by which the reed is "carried by a spring cap and swivel in the top rail" of the slay, and thus when the shuttle is caught in the shed the reed is forced back and acts upon levers which stop the loom. This is an arrangement by which all uncertainty of action is done away with. The result of the loose reed, which is applicable to all lighter kinds of cloth, is that it has enabled the looms to be worked much quicker than was previously practicable. A 40lb. loom, for instance, which before the invention of the loose reed, might be worked at the rate of 100 picks per minute, could afterwards be worked at 180 to 200 picks per minute—or at an increased speed of more than 100 per cent., and further improvements have increased the practicable speed at which the same loom can be worked to about 230 picks per minute.

Messrs. Harrison, of Blackburn, had a loom on the loose-reed principle in the Exhibition of 1862, which was capable of being worked at 300 picks per minute. The loose reed is not applicable to the weaving of heavy fabrics. The force with which the weft in the heavier class of goods requires to be beaten up is greater than could be applied with a slay fitted with the loose-reed principle. The loom, therefore, for weaving heavy fabrics is fitted with a fast reed, and it is left to an application termed a "stop rod" to stop the loom when the shuttle is prevented from any cause from completing its course through the warp. The stop rod is acted upon by the shuttle as it arrives at each end of the slay; and, on its failing to arrive at either end, the top rod falls upon a movable bracket, and instantaneously stops the loom. But this sudden stoppage of the loom in the first application of the stop rod was attended by a great shock, which caused damage not only to the warp but to the loom itself; and as the stop rod proved in practice very uncertain in its working, the mishaps it was intended to guard against were not always prevented.

This led to another improvement of considerable importance as applicable to fast reed looms, an improvement which goes by the name of the "brake," which was patented by Mr. John Sellers of Burnley, in 1845, and by which the loom can be stopped instantaneously, whatever the speed at which it may be working, without the great shock to the machinery which the stop rod produces when used without the brake. These several contrivances for stopping the loom, most of them self-acting, requiring neither the presence nor the intervention of the weaver, effectually obviate the

mischief which would otherwise be inevitable; and which in the absence of these mechanical appliances the most watchful vigilance, supposing no more than one loom was under the care of each operative, would be powerless to prevent.

In addition to the foregoing improvements in looms are now applied the cast-iron taking-up roller, fluted and chased, the advantage of which is its great durability and strength; this roller is particularly adapted for very strong fabrics. The sheet-iron taking-up roller covered with composition; this roller always presents a perfectly level surface to the cloth, being on this account made superior to the ordinary wooden roller covered with emery, the disadvantage of which is that it changes with the temperature, in damp weather becoming swollen, and in dry weather warped or crooked, causing great irregularity in the cloth. The sheet-iron roller always remains at one diameter. The wooden taking-up rollers, made in halves, or lagged, with a shaft through, and covered with metallic surfacing, are generally applied to linen looms. The cloth roller: this roller is applied to looms for weaving very strong goods; it is placed at the back of the taking-up roller, so as to get more hold of the cloth, and thus prevent it slipping, which would cause thick places in the cloth. The cloth board is placed in front of the taking-up roller, to prevent the weaver soiling the cloth; it is more especially used for linen looms, and when the weft is woven wet. The under-picking motion is generally adopted in linen weaving, though it does not possess any advantage over the ordinary pick, except that it is cleaner, not requiring a fly spindle, and thus doing away with oil in the shuttle box. The over-picking motion is always used in cotton weaving, and sometimes for linen. The treading motion: plain with large and small tappets, two and four leaf twills, two, three, and four, and two and three leaf, also five shaft twills, Woodcroft's patent section tappets, for any number of shafts, Jacquard's and Dobby's. The weighting motion: compound weighing motion, double compound, and the late John Collier's (of Halifax) patent lifting-off motion, which delivers the warp positively, as required by the taking-up motion for the cloth. These two motions work in concert, and with such precision that the warp is delivered from the yarn beam with the same regularity when the beam is almost empty as when it is full. The only improvement in winding is the form of the machine, and the invention of a motion to shape the bobbin, by means of a heart and lever in connection, and which works the traverse.

The kind of warping machine used in 1830 was the old ball warping, worked by hand. In 1843 Mr. W. Kenworthy, of Blackburn, invented a new warping machine to wind yarn from the bobbin direct on to the warper's beam for the sizing machine. This machine is supplied with a letting-back motion, whereby, when a thread is broken, the motion of the beam roller is reversed, and by the aid of a simple mechanical arrangement the thread may easily be found and re-united. An improvement was made in this machine by the application of a self-acting stopping and measuring motion, by means of which the machine is immediately stopped when the required length is wound on the beam. Further improvements on the machine are the expanding and contracting comb and drum, which can be expanded or contracted according to the width of beams required to be used.

The latest improvement in this machine is by Messrs. Howard and Bullough, of Accrington, by dispensing with the letting-off motion, and applying their patent self-stopping motion, which stops the machine immediately should a single end break. The sizing machine used in 1830 was the old ball sizing, which continued to be used until 1839, when it was displaced by the invention of the tape-sizing machine, by Mr. William Kenworthy, of Blackburn. This machine did the work of six old ball sizing machines, and required only one attendant operative, whose wages were about £3 per week; but the production of the present slasher sizing machine (comprising the patents of Mr. Bullough, of Accrington) is about 10,000 yards of warp per week, or sufficient to supply at least 300 looms weaving an ordinary class of cloth, say shirtings; and this machine needs an operative who, being little more than a common labouring man, requires only about 26s. per week, thus the production, which previous to Mr. Kenworthy's invention would have cost £18 per week in wages, and which was effected in 1851 for £3 per week, is now done for less than 24s. per week; and as the present machine does so much more work, it follows that fewer machines are needed, consequently space and power are economised as well as wages.

The most important appliances to the present sizing machine are the patent friction motion, by Messrs. Harrison and Sons, machinists, of Blackburn, to regulate the tension of the yarn whilst in a wet state. The elasticity is thus retained, consequently the production of cloth is much increased. By this arrangement, coarse and fine yarns can be sized with equal facility, as also yarns of medium and low qualities. And the patent self-acting diminishing valve and gauge, regulates the pressure of steam previous to its passing into the cylinder, and only allows a sufficient quantity of steam for drying purposes. When the machine is stopped, and the cylinders have received the pressure which is indicated on the gauge, the valve immediately closes, and no more steam is allowed to pass until the machine begins to work again. By the knitting machine, to knit healds or heddles by power, a superior quality of heald is produced, with none of the irregularity which occurs in hand made healds. Another important advantage in this machine is a saving of 50 per cent in the cost of production. Folding, or plaiting and measuring machines, by power, for measuring the cloth and laying it in folds after it comes from the loom, and previous to it being put in bundles or bales. This machine folds and measures the cloth with the greatest regularity and precision, and effects a very important saving in this department, as compared with the old hooking system. The hydraulic press, for pressing the cloth whilst being made up into bundles or bales, is now in general use, and is a great improvement on the old wooden screw press. Finally, in 1764, the cotton imported into this country was 3,870,392lb.; in 1830, the cotton consumed in this country was 239,837,350lb.; and in 1860 it was 1,083,600,003lb.; showing in increase during the 30 years of over 400 per cent. The respective numbers of the mills, spindles, looms, and workers at the dates named will be in proportion to the different quantities of cotton consumed, after making due allowance for the increased rate of production previously shown in this paper, viz.:—

	1830.		1860.
Spindles	12,000,000	......	40,000,000
Looms	150,000	......	400,000
Mills	2,500	......	7,100
Workers	200,000	......	500,000

The following account shows the quantity of raw cotton consumed in the chief manufacturing countries in the year 1856:—

	lb.
Great Britain	920,000,000
Russia, Germany, Holland, and Belgium	256,000,000
France	211,000,000
Spain	48,000,000
Countries bordering on the Adriatic	39,000,000
United States	265,000,000
Sundries, Mediterranean, &c.	56,000,000
Total	1,795,000,000

Mr. Newmarch said it was important to observe that as the use of machinery had increased, the wages and condition of the operatives had improved.

Professor Rogers said the general impression of manufacturers in Lancashire was that when trade revived the increase in the wages of the operatives would be from thirty to forty per cent. That improvement would also have its effect on the wages of the agricultural labourers, which were now very small.

Mr Rumsey said the certainty of a high rate of wages was acknowledged in Lancashire; there were not at present sufficient hands to work the machinery of all the mills.

Lord Stanley said he believed the revival of trade in Lancashire would be independent of the arrival of cotton in large quantities from America; for if there was a great demand there were plenty of countries where cotton could and would be grown. What created the greatest difficulty during the last few years was not so much the cessation of the supply of cotton, but the temporary cessation of that supply coupled with the fact that no man could tell how soon the supply would be renewed. It would have been better for all parties, as far as their interests were concerned, if they could have had an absolute guarantee that for five or six years no cotton would have come from America, for then people would have invested money in growing cotton in other parts of the world, without the danger they felt now of being underbid by the renewal of the American supply. He believed that there would be a considerable increase of wages, but he was not sure that that would have any effect on the agricultural labourers, for two reasons:—First, it was exceedingly difficult to induce an agricultural labourer, as a rule, to move out of the locality in which he had been in the habit of living. The changes in the Poor Law and Law of Settlement had been thoroughly beneficial. At the same time the effect of the former laws in keeping the agricultural population where they were had, he thought, been somewhat overrated. Again, if the supply of agricultural labour was considerably diminished, he was sceptical as to its having the effect anticipated upon the rent of land, because the introduction of labour saving machinery in agriculture was comparatively new. He had no doubt that all the agricultural operations of the country might be carried on with one-half the amount of manual labour now applied to them. Of course, the labourers who remained would be more highly paid, the number being smaller. It did not follow that the total cost of agricultural produce would be greater than it was at present. Rural parishes could well throw off their surplus populations into towns, as they did now; and if there was a temporary scarcity of labour, it would be met here, as it had been in America, by appliances which would make the same amount of labour go further.

THE EXTENSIVE AND EXTENDING APPLICATIONS OF THE STEAM ENGINE.

It is not very many years ago, since a celebrated philosopher foretold that the steam engine, then limited in its application, was destined to raise man in the scale of society, by doing his drudgery, and by leaving him to the uninterrupted exercise of intellectual employment, or skilled labour in preference. Time and experience, together, have endorsed, and given becoming gravity to his prophetic assertion, by realising it, and thus proving the soundness of his judgment. Intellectual employment is more profound, because more concentrated on, whilst analysing its accumulating experience. Skilled labour has become, and is becoming still more skilful, by reason of the steam engine leaving man to the superior part of his operations, and by relieving him of the confusion, the distraction of the less skilful and laborious part, whilst it fulfils its duties with reliable promptitude and precision.

If we contemplate this progress from a lower, a utilitarian point of view, with the ominous £ s. d. in perspective, we may get another interesting prospect. We may now see the wide range of a growing desire, to use the steam engine, wherever mere labour or force is employed. It is less expensive and more subject to control. It relieves employers from a state of dependence on the caprices of the less informed portion of the employed. Builders, contractors, manufacturers, merchants, shipowners, farmers, and even the barbers are making progressive changes in their establishments, and welcoming the steam engine as a familiar thing. To each of these and others, time is valuable in business. Take an example or two, by way of illustration. We have seen the heavily laden ship arrive, and her cargo taken out, and replaced with an outward bound freight, *by the aid of steam,* before the captain's laundress had completed her task on his accumulated stock of soiled linen. The steam engine stands ready for duty on the wharves, it floats from ship to ship in our rivers, or docks, and loads or unloads vessel after vessel. The portable steam engine takes up about the same space as a suitable winch, and can be disposed for one engine to work one of the three hatchways; thus three engines may work at the same time, hence the dispatch, to the profit of the merchants, and of the shipowners. The farmer is proud of such a powerful team, which consumes no food when idle, and richly deserves a few shovels of coals when at work. He freely wagers heavy stakes, but not on a trotting horse, this time, nor on the weight of his fat pig, but on the superior ability of his engine and threshing machine, to fit so many hundreds of bushels of corn, then in the sheaf, for the market in a given time. The provincial papers are loud in praise of his "pluck," and of his success. His friends—when is a successful man without friends?—congratulate him, and determine to follow his "noble" example. Thus steam engines multiply in that direction also. Again, the steam engine being well poised on suitable wheels, some fine day a couple of horses are "hitched on," and in a few minutes it is ready for work in the "stack-yard." The stack of corn is not now slowly carted away to the barn, to be threshed, but is promptly threshed on the spot, and the grain is made ready for market, and bagged, then and there, by the little steam engine which chewed the cud for the cows and calves. The steam engine fills the warehouse of the merchant with goods, or distributes the contents to his customers, with the utmost promptitude. We may daily see the steam engine driving piles, or pumping water, or raising huge masses of stone, or timber into their proper places; whilst skilled labour calmly directs the operation, with undistracted confidence.

Agriculturists—ever cautious and ever alive to their own interests—have watched over the steam engine, to comprehend its usefulness and its economy. Many have availed themselves of its valuable assistance, and are extending the sphere of its usefulness to their own advantage, and to the advantage of the makers of engines. Steam cultivation, is spreading over the face of the country, to such an extent, that the Royal Agricultural Society has turned its attention to this important subject, with a view to accumulate some desirable statistics, as a source of information to the more cautious, which must be the more valuable as it accumulates. We close our present remarks, with an extract from the proceedings of that valuable society.

STEAM CULTIVATION INQUIRY.

Lord Vernon, Chairman, stated that the committee recommended that the following instructions be issued for the guidance of members of the Steam Cultivation Inspection Committees.

On receipt of instructions from the Council to visit any particular district, they will be furnished with—

1. A list of all the farms in the district where steam cultivation has been adopted.

2. A selection from the list of farms to be inspected, and the replies received by the society from the owners of steam cultivation implements to the schedule of questions addressed to them. Although the inspection committees are not to consider themselves precluded from inspecting a farm which is not on their list, on being satisfied that there are sufficient reasons for doing so, it must be their object to limit themselves as nearly as possible, to the number of days allotted to the districts assigned to them. In order the better to accomplish this, they will be at liberty to omit inspecting any of the selected farms which, from information received, they may consider not to possess any especial interest, more particularly if distant from their main route. In either case they will be expected to report to Hanover-square their reasons for deviating from the prescribed list.

3. The inquiry should be specially directed to the following points:—

i. The cost per acre, the depth and nature, including the various items of expenditure for each kind of work.
ii. A special investigation into the age of the machine, and the amount paid annually for repairs, stating the nature of breakages, and their causes.
iii. How far the adoption of steam cultivation has assisted the drainage of strong lands, how far the cropping of the farm has been changed by the adoption of steam cultivation—more especially to what extent autumn cultivation has increased the growth of green crops, and how far the productiveness of the soil has been increased by steam cultivation.
iv. The number of working days on which the engine power has been used, for the purpose of steam cultivation, on or off the farm.
v. The number of days, in which it has been used for other purposes, on or off the farm, stating the nature of the work done, daily cost and amount charged when let on hire.
vi. The number of days lost by breakage and other causes.
vii. In the cases of steam-ploughs, &c., let out for hire, to ascertain what loss of wages occur from the non-employment of the men, this being an item of expense against the apparatus.
viii. The consideration of the economical supply of water for steam cultivation.
ix. The economical mode of arranging and forming roads and headlands for steam cultivation.

4. In the exercise of the power thus given to the inspection committee of deviating from the list of selected farms, they are requested to keep prominently in mind that one of the main objects of the inquiry is, to obtain a report of the comparative results, obtained by the use of different kinds of steam apparatus, the different systems of cultivation adopted, and especially their adaptation to large or small farms, and any other points which they may consider to be deserving notice.

5. The report of the inspection committee to be made within a month after the completion of the inspection of a district.

The report was adopted.

THE WATER SUPPLY IN RELATION TO ITS PURITY.

Now that cholera is, unfortunately, rending family ties among us, its origin and progress is assiduously watched over, to detect, if possible, the channel of communication, the better to arrest that progress. The medical profession is prepared with the resources of science, to check the spread of cholera wherever it is detected. Some have raised a question on the purity of our water supplies, as if the plans of our engineers, for purifying this water, were inapplicable, or insufficient for the purpose intended. We therefore turn with pleasure to a direct assurance, of the able editor of the *Chemical News*, that the water supply to the metropolis is sufficiently pure, whilst he more than hints at a probable source of contamination under our own roof, and consequently under our personal controul. The article in question, so highly recommends itself to all, that we willingly extend the sphere of its usefulness, by extracting it here *in extenso*:—

"The analysis of the metropolitan waters during the month of July, shows that in every case, there is less than the average proportion of saline and organic matters, and the reduction of the latter, which is the most important constituent of potable water, is most marked in the waters derived from other sources than the River Thames; for while the amount of organic impurity in the latter, has ranged from 0·49 to 0·76 of a grain per gallon, that of the former has been from 0·2 to 0·4 per gallon. Indeed, the quantity of organic matter in the Kent water, has fallen from an average of 0·2 of a grain, to 0·02; that of the New River from 0·46 to 0·2; and that of the East London from 0·53 to 0·4. These reductions in the quantity of organic matter, are chiefly due to the care with which the processes of filtration are conducted; and if these analytical results are compared with those of a few years ago, the improvement is still more remarkable. It is very probable, however, that the most perfect processes of purification, so far as they can be used at the works of the water-companies, will never be sufficient to insure such a purity of water, as the complete removal of those subtle agents of disease, which even the most refined appliances of the chemist have failed to discover. It may, therefore, well be, that all discoverable traces of organic matter may be removed from water, and yet it may still contain enough of the minute germs of disease to manifest its morbific action wherever it is used. Experience, indeed, teaches

us, that it is not the quantity of organic matter in water, so much as its quality which determines its dangerous properties; and if it is true, as modern pathological science has almost demonstrated, that the real agent of such diseases as infectious fevers, cholera, the rinderpest, and other allied zymotic maladies, are living germs, and not a gas, or vapour, or dead organic miasm, it must rest with the phpsiologist, rather than with the chemist, to decide on the means which are best suited for their destruction; and it is more than probable, that the chemist would be putting forward very dangerous propositions, if by relying on his science alone, he ventured to dogmatise on so difficult a subject. That which has been abundantly proved in respect of small-pox, and some other infectious diseases is very applicable to the present inquiry, in so far as it relates to the more than possible existence of choleraic germs in the water we drink. The agents of those diseases are unquestionably living germs capable of remaining dormant for an uncertain, but nevertheless not indefinite period, and then springing into activity, and multiplying themselves without limit, directly they find the condition necessary for their active development. But whether these germs are susceptible of oxidation, like common dead organic matter passing through its final stages of decay, is more than chemical science alone can determine. The analogies in physiology are against such a supposition, and they warn us not to receive it, even as a possible fact. That which we do know, however, is, that these germs are destroyed by the temperature of boiling water; that they are killed by all caustic substances, as chloride of zinc, chloride of iron,* &c., and that they cannot resist the action of certain agents, as sulphurous acid and its salts, carbolic acid which, &c., act on them after the manner of specific poisons. We must, therefore, look to these agents, rather than to processes of oxidation, for reliable prophylactics; and in the case before us, *the only agent on which we can confidently rely is heat, for if the infected water be boiled, the choleraic germs will be rendered innocuous.* That the destruction of decaying organic matter, in water, is of the greatest importance, there can be no doubt, for experience has proved that it also is productive of disease. It is, moreover, certain that organic matters of this description, are rapidly oxidised by permanganate of potash,† and by filtration through animal charcoal, and charcoal mixed with certain compounds of iron; but it is more than doubtful, even if it were practicable, whether such processes of purification should be used by the water companies at the sources of supply—*seeing how many causes of pollution exist between those sources and the consumer.* Besides which, it must not be forgotten, that only a very small part of the water delivered by the companies is used for primary domestic purposes.—the great bulk of it being employed for flushing closets, drains, and sewers; for watering streets, and for various manufacturing operations. It would, therefore, manifestly be an unnecessarily wasteful application of a tedious and expensive process, to do that at the works, which can be so easily, so surely, and *so much more economically done at the point of consumption.* But, after all, the most important consideration at the present time, is the means of obtaining a constant water supply, so that *the prolific sources of contamination and of real danger to the community, the filthy butts and cisterns may be entirely abolished.* The very first step towards the attainment of this object must be made by *the public themselves;* for it is idle to expect a constant supply, while there is the present imperfect condition of almost every household service. If, indeed, such a supply were at once given to us, it would assuredly fail, for all the water of the Welsh hills would be insufficient to maintain it. The daily supply of water to London is at the rate of about thirty gallons per head, whereas experience has proved, in many instances, that with a well-regulated constant service it need not exceed twenty gallons a head. As a matter of economy, therefore, as well as of public health, it is high time that the consumer should make preparation for such a supply, in the way that the Act of Parliament directs, and then there would be no difficulty in applying processes of purification at every point where the water is used for domestic purposes. At the present juncture, *it is advisable that all water stored in butts or cisterns, should be boiled before it is drunk, and when practicable, it should be previously filtered* through animal charcoal, or charcoal associated with proper compounds of iron; and, failing this, it may be treated with *a little* of Condy's solution of permanganate of potash, until it retains a very pale, but decided tint of rose red. In all cases, however, it should be boiled."

The *Medical Times and Gazette* says,—"Let us suppose a water of a bad, or at least a suspicious, marshy smell; the addition of *one or more* drops of "Condy" or of one of the finer solutions of permanganate, will speedily remove that smell and taste, and make the water fresher and nicer. The quicker the discolouration the greater the need of it. If water so treated, with a slight pink colour remaining, be passed through a filter, it comes out perfectly clear and colourless; but, without filtering, it may be used for cooking or making tea and coffee, after the brown sediment has settled. Most assuredly, any one thirsty enough to drink raw London water just now, had better use the permanganate and a filter too.

* It may be desirable to note, that these agents must be used with great caution, else we kill instead of cure, not only the supposed living germs, but also those who drink water so treated.—Ed. A.

† The following excellent suggestion has been made, as a simple yet perfectly sufficient mode of deciding the question of the purity of water. Fill any well-cleaned phial with the suspected water, add to it one or two drops of a concentrated solution of permanganate of potash. Cork it with a new, clean cork, and shake the bottle well. On removing the cork, the water should now be of a light rose-pink colour, when looked at perpendicularly, through the phial, at a sheet of white paper behind it. If this tint remains unchanged during the space of twenty-four hours, in a cool place, and corked up, it is a satisfactory proof of the purity of the water. If the colour changes to a brick red or yellowish colour, then promptly cleanse the water-butt or cistern which received it; else filter through animal charcoal.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The last ordinary monthly meeting of the Executive Committee of this Association was held at the Offices, 41, Corporation-street, Manchester, on Tuesday, July 31st, 1866, William Fairbairn, Esq., C.E., F.R.S., LL.D., &c., President, in the chair, when Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—

"During the last month 182 engines and 340 boilers, have been examined, and two of the latter tested by hydraulic pressure. Of the boiler examinations, 201 have been external, 10 internal, and 129 entire. In the boilers examined, 87 defects have been discovered, 7 of those being dangerous.

Tabular Statement of Defects, Omissions, &c., met with in the Boilers examined from June 23rd, 1866, to July 27th, 1866, inclusive.

Description.	Number of Cases met with..		
	Dangerous.	Ordinary.	Total.
Defects in Boiler.			
Furnaces out of Shape	...	1	1
Fracture	...	9	9
Blistered Plates	1	3	4
Corrosion—Internal	1	4	5
Ditto External	2	19	21
Grooving—Internal	...	4	4
Ditto External	...	2	2
Total Number of Defects in Boiler ...	4	42	46
Defective Fittings.			
Feed Apparatus out of order	1	5	6
Water Gauges ditto	...	4	4
Blow-out Apparatus ditto	...	3	3
Fusible Plugs ditto	1	...	1
Safety Valves ditto	...	4	4
Pressure Gauges ditto	...	4	4
Total Number of Defective Fittings ...	2	20	22
Omissions.			
Boilers without Glass Water Gauges	...	1	1
Ditto Safety Valves	...	...	...
Ditto Pressure Gauges	...	...	...
Ditto Blow-out Apparatus	...	...	...
Ditto Feed back pressure valves	...	14	14
Total Number of Omissions	...	15	15
Cases of Over Pressure	...	3	3
Cases of Deficiency of Water	1	...	1
Gross Total	7	80	87

Of some of the defects mentioned in the preceding table details may now be given.

Corrosion.—Internal.—Some corrosive waters not only waste and indent the surface of boilers internally, but also destroy the vitality of the metal, so that the edge of the overlap may be cut away with a few slight blows with the hammer, and the rivet heads knocked off with a hand chisel only, and easily pulverised. Such was the character of the defects found in one of the boilers examined during the past month, and which was at once laid off by the owners, and condemned as soon as its condition was pointed out by the Association. The above shows the importance of carefully testing corroded rivet heads with a hammer.

Corrosion.—External.—Both the dangerous cases referred to in the table arose from leakage at the joints of boiler mountings, in consequence of their being bolted to the shell instead of rivetted. The plates were so eaten away that in one case the inspector scraped a hole through with his chisel, while this could easily have been repeated in the other. One of the mountings was a cast iron manhole mouthpiece of somewhat large size, and as the corrosion extended in a groove all round it, the boiler was clearly unsafe to be worked, and was immediately laid off. This encircling groove was not very easy of detection, since, although nearly eating through the plate, it was only three-eighths to half an inch wide, and almost buried under the edge of the casting; added to which it was filled up with tar with which the boiler had been coated. There may be others in a similar condition for which this may he a caution. All mountings, instead of being bolted to boilers, should be attached with suitable fitting blocks rivetted to the shell.

Deficiency of Water.—This arose at night time when the fires were banked up, from the attendant's omitting to close the feed stop valve, there being no self-acting back-pressure valve, and the feed inlet being below the furnace crowns. The importance of every boiler being fitted with a good self-acting feed back-pressure valve, as well as of the feed inlet being above the level of the furnace crowns has been frequently pointed out in previous reports.* The furnace crown was fitted with one of those fusible plugs in which the alloy is in the shape of a washer about the size of a penny piece, having a copper button in the centre of it. This did not, however, prevent the plates becoming red hot. The plug did not put out the fire, or, properly speaking, go off at all. A little piece of the alloy melted away on one side and allowed a slight escape of steam, which fortunately attracted the attention of a workman, who at once examined the boiler and found the furnace crown red hot.

Explosions.

During the past month two explosions have occurred, by which five persons have been killed, and one other injured. Neither of the boilers was under the inspection of this Association.

Tabular Statement of Explosions, from June 23rd, 1866, to July 27th, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
33	July 2	Plain Cylindrical Egg-ended. Externally-fired	4	0	4
34	July 16	Particulars not yet fully ascertained..................	1	1	2
		Total..................	5	1	6

No. 33 Explosion occurred at a colliery at half-past three o'clock on the morning of Monday, July 2nd, and resulted in the loss of four lives.

The boiler, which was not under the inspection of this Association, was of the plain cylindrical externally-fired class, its length being 30ft., its diameter 6ft., and the thickness of the plates ⅜in., while the pressure at which the safety valves were loaded was 30lb. per square inch. From the evidence given at the inquest it appeared that the boiler was nine years old, was set with a wheel flue, fed with hot water, and had been cleaned and repaired, when five new plates were put in, but a week before it burst. Also, that at the time of the explosion the boiler had plenty of water in it, and that the pressure of the steam did not exceed 27lb. on the square inch; while, on subsequent examination, the plates were found to be of good quality, and to present no evidence either of flaws or of having been overheated. The engineer to the colliery, who stated that he had held the position for sixteen years, was "very well accustomed to boilers," and had the superintendence of all the enginemen, gave it in evidence that he could not in any way account for the explosion, and thought that there must have been something more powerful than steam to produce it. The jury brought in a verdict that "the four lives were lost by the explosion of a boiler at the colliery, but what caused the explosion there was no evidence to show."

Such evidence and such verdicts, though but too common, are not only unsatisfactory, but positively mischievous, and can only tend to perpetuate explosions, as is shown by the occurrence of the one under consideration. But five weeks before a very similar explosion occurred to another colliery boiler belonging to the same proprietor, and under the superintendence of the same engineer; while at the inquest evidence to the same effect to that just described was given by the superintending engineer, the smith who had repaired the boiler, and the engineman, all of whom considered the bursting of the boiler to be unaccountable, so that the jury gave it in their verdict that "what caused the explosion there was no evidence to show." The tendency of such evidence and verdicts to reproduce rather than to prevent these disasters was pointed out in last month's report in the remarks on this explosion, which ranks as No. 24 for the present year, though it was hardly expected that they would be corroborated by a second explosion at the same works within the short space of five weeks.

As long as explosions are considered to he altogether unaccountable by those who have charge of the boilers, and this view is endorsed at coroner's inquests, it will be seen that nothing is done for their prevention, and boilers similarly dangerous to those which have exploded, will be worked on till other explosions occur and more lives are lost, when at the inquests the same stereotyped evidence will in all probability be repeated, viz.:—That the boilers were very good, very strong, and perfectly sound; that the explosions were altogether unaccountable, and could not be helped.

There is nothing, however, either unaccountable or unavoidable in these explosions. The majority of those at collieries arise simply from the use of plain cylindrical externally-fired boilers, which, as has been repeatedly pointed out in previous reports, are so dangerous and treacherous as to be entirely untrustworthy. Every fresh explosion, which occurs to this class of boiler, is an additional illustration of this. The two explosions, recorded in last month's report, both took place very shortly after the boilers had been repaired and passed as sound, one of them having been cleaned and examined but the very day before it burst, while the boiler in the present case had worked but five days and nights since being repaired and cleaned, when it is stated that the boiler was found perfectly sound, and considered safe. This treacherous class of boiler should be discarded altogether, and, until this be done, these so-called unaccountable and unavoidable explosions will continue to recur month after month, as they do at present, with their attendant loss of life.

Explosions resulting from Collapse of Flue Tubes.

Several explosions, the particulars of which have not yet been reported, have occurred, during the last few months, to internally-fired single-flued or "Cornish" boilers, all of which might have been prevented by strengthening the furnace tubes with encircling hoops or flanged seams. The particulars of five such explosions may now he given, while two others have been reported to me, which, there is little doubt, arose from the same cause, but sufficiently full details have not yet been received to enable me to speak quite positively. Not one of the boilers in question was under the charge of this Association. The five explosions referred to are Nos. 3A, 10A, 11, 17, and 26, while the details are as follows:—

No. 3A explosion, which resulted in the loss of one life, occurred at half-past four o'clock on the afternoon of Tuesday, January 9th, at a saw-mill, to a boiler 28ft. long, 6ft. 6in. diameter in the shell, and 3ft. 6in. in the furnace tube, which was made of four plates in its circumference, three of which were three-eighths of an inch in thickness, and the fourth seven-sixteenths of an inch, the ordinary working pressure being 45lb. per square inch. The boiler was in good condition, and well equipped with mountings, while the plates of the furnace tube are reported not to have presented the slightest appearance of having been overheated. It seems that the engineman had noticed on several occasions, when getting up steam, certain vibrations in the tube, and imagining that these arose from its deflection consequent on its weight, hung it up to the top of the shell by a couple of stay rods. These, however, proved of no avail. The furnace tube collapsed in an inclined direction, midway between the vertical and horizontal. Had encircling hoops been added to the tube instead of the stay rods, the explosion would have been prevented.

No. 10A explosion happened at a quarter before twelve on the morning of Monday, February 26th, to a boiler employed at a currier's factory. Fortunately no one was killed, and only one person injured. The boiler, which was a second-hand one, had just been reset, and been at work but a few hours when the furnace crown collapsed, on which the steam and water rushed out from the rent and did considerable damage to the surrounding property, reducing the boilerhouse and adjoining sheds to a wreck, and scattering the *débris* to a considerable distance. The length of the boiler was 21ft., the diameter of the shell 5ft., and of the furnace tube 2ft. 11in., the thickness of the plates being three-eights of an inch, while the pressure of the steam on the square inch shortly before the explosion was 64lb. A furnace tube of such dimensions, especially when not perfectly circular, is quite unfit to be worked at as high a pressure as this one was, viz., 64lb., and all similar boilers should at once be strengthened, or they will only be worked at the risk of failing in the same way as this one did.

No. 11 explosion happened at a mine, on Saturday, March 3rd, and resulted in the death of one man. The boiler was 31ft. 9in. in length, and had a diameter of 5ft. 9in. in the shell, and 3ft. 8in. in the furnace tube, the thickness of the plates being three-eighths of an inch, and the load upon the safety valve 40lb. on the square inch. The tube collapsed laterally, from which it appears probable it was not truly circular; but, even if it had been, such a flue could not be prudently worked at a pressure of 40lb. on the square inch, unless strengthened with encircling hoops, or other approved means.

No. 17 explosion, which was of a much more disastrous character than either of the preceding, resulting in the death of five persons, as well as in injury to five others, occurred at ten minutes past six o'clock on the evening of Wednesday, April 4th, at a tinplate works. In this instance not only did the tube collapse, but both ends of the boiler were completely torn away, the body of the shell being blown in one direction and a considerable portion of the furnace tube in another, while the buildings of the works were seriously damaged, the roofs dismantled, and the whole thrown into utter confusion. The length of the boiler was 30ft., the diameter of the shell 7ft., and of the furnace tube 4ft., while the plates were seven-sixteenths of an inch in thickness, and the pressure of the steam 43lb. per square inch.

Note.—*See remarks under "Furnaces out of Shape," in Association's printed monthly Report for May. 1866.

This pressure, in the absence of any strengthening rings, was excessive for such a tube, and more particularly so if as all out of the circular shape, which is generally the case in those of so large a diameter, unless of first class workmanship, which could hardly be expected to be met with in a boiler made in the locality in which this one was.

At the inquest some rather curious views were expressed. An application to the Board of Trade for a Government Inspector to assist in the investigation had met with a refusal, coupled with the suggestion that the coroner should, if he considered it necessary obtain the assistance of some duly qualified engineer in the neighbourhood. This, however, the coroner stated to the jury he deemed superfluous, since several of them were practically acquainted with the construction of boilers, and able he considered to get at the whole facts of the case themselves. One of the jurymen stated, for the information of his fellow jurors, that a furnace tube of a boiler would withstand the same pressure of steam as the shell, if only half its diameter and made of the same thickness of plate; and as in the boiler under consideration the tube a little exceeded half the diameter of the shell, it was somewhat weaker, but that had nothing to do with the explosion. It need scarcely be said that this rule is as empirical as it is false and dangerous. Another juryman undertook to estimate the precise per centage of strength that furnace tubes lost from being overheated from shortness of water; while, in the opinion of a third juror, if the plates became overheated the steam would, from oxydising the iron, blow up the boiler. The coroner stated it was clear the explosion had arisen from neglect in one or two ways, either in generating too much steam or giving the boiler too little water, but no one pointed out that the explosion arose from the weakness of the furnace tube, or called attention to the fatal defect in its construction of omitting strengthening rings, &c. The jury returned a verdict of 'Accidental Death,' caused by the explosion of a steam boiler in consequence of the smallness of the safety-valve, and thus closed the inquiry without having thrown any light on the true cause of the explosion, so that it is feared that in the neighbourhood in which this explosion occurred makers will still continue to turn out unsafe boilers, and firemen to attend to them in total ignorance of their danger.

No. 26 explosion took place at a mine on Monday, May 28th, one person being killed and three others injured.

The boiler was of the single-flue internally-fired 'Cornish' class, its length being 30ft. 8in., its diameter 6ft. 8in. in the shell, and 4ft. in the furnace tube, some of the plates of which measured seven-sixteenths, and others from that to three-eighths of an inch in thickness. There were two safety-valves on the boiler loaded to a pressure of 40lb. on the square inch, one glass water gauge, and two gauge taps.

The internal flue tube collapsed from one end to the other, with the exception of about 4ft. at the front end over the fire, where the tube retained its original shape almost uninjured, the collapse taking place in a vertical direction, the crown flattening down to the bottom of the flue, while about 8ft. of the tube at the back end of the boiler was severed from the remainder and thrown to a distance of about 80 yards, the shell with the other part of the flue tube, weighing about 9 tons, being thrown in an opposite direction for about 70 yards. At the moment of explosion the engine was standing, and had been doing so for twenty minutes, the dampers being shut, and the steam, it is reported, blowing off gently; while the attendant, who is stated to be a trustworthy and perfectly competent workman, says that when the engine stopped there were 9in. of water in the glass; and, also, that he tried the top gauge tap.

A good deal of discussion has arisen as to the cause of this explosion, and it has been attributed, as usual, to shortness of water. Had this been the case the plates of the furnace crown, immediately over the fire, would have been the first to have given way, whereas, as already stated, the tube failed at the back end, and retained its original shape at the front, added to which the tube was of such dimensions that it could not be prudently worked at so high a pressure as it was, so that it is thought there is no reason to doubt that the explosion arose from weakness of the internal flue tube, and not from shortness of water. It must not be forgotten that when an engine is standing and the safety-valves are blowing off, as was the case in the present instance, that the steam pressure will always exceed the load on the safety-valves more or less, and it must again be repeated that it has a most important influence on the strength of internal flue tubes, whether they be truly circular or not; which is a consideration too much lost sight of, while it explains the apparent anomaly of one boiler exploiding and another of similar dimensions working safely. Tubes made with plates overlapping can never be truly circular. Many of those now under inspection are made without any lap at all, the ends being welded or else butted with a joint strip, so as to accurately maintain the circular shape. Also a belt of T iron, welded up into a solid hoop is introduced at each ring seam of rivets. With this arrangement plates three-eighths of an inch in thickness, istead of those seven-sixteenths or half an inch, are found to be ample, and to be perfectly safe at a pressure of 60lb. per square innch or even or even higher. Had this arrangement been adopted in the present instance the explosion would not have happened.

It is feared that in the district which this explosion occurred many boilers of very similar proportions are at work, and under these circumstances it is no kindness to the steam user, and especially to the poor firemen, to ennuciate half truths. It must, therefore, plainly be stated that all such boilers are dangerous, that they should be immediately stopped and the furnace tubes strengthened. This in some cases may be done in place by the addition of angle iron hoops; while in others, where the furnace tubes are much out of the circular shape, it might be better to remove them altogether.

In Making Iron, the weight of the air admitted to the furnace is rather more than the weight of coal, ore, and limestone used.

INSTITUTION OF MECHANICAL ENGINEERS.

The annual meeting of this institution commenced in Manchester, on Tuesday, the 31st July, in the lecture theatre of the Mechanics' Institution. Mr. Jos. Whitworth, president, occupied the chair. He opened the meeting, by thanking the members for having again elected him president, it being now the third time they had conferred upon him that honour. The attendance was good; among the gentlemen present, we noticed Mr. Fairbairn, Mr. Robert Napier, Mr. Ramsbottom (of Crewe), Mr. Fothergill, Mr. Platt, Mr. Bramwell, Mr. Shanks (of London), Mr. Peacock (of Gorton), Mr. Mac Farland (of the Birmingham Small Arms Company), &c., &c. It is matter for regret, that members are prevented, by the rules of this society, communicating extracts of their papers, or copies of the interesting diagrams. Mr. W. P. Marshall, the secretary, after some preliminary business, read a paper by the president, "On the Proof of Guns, by Measurement, with description of the Instrument employed." The best length for a solid projectile is three diameters, and the total weight of powder the gun can wholly consume, is one-seventh of the weight of the projectile. Applying this rule to the 600-pounder gun now in our service, which has a bore of 13in., it ought to fire a 990-lb. shot, and consume 141lbs. of powder, while the American 15-in. bore gun should fire a 1,522-lb. shot, with 217lbs. of powder. These data showed that in these cases the bores were too large, and that the guns themselves were inefficient. The instrument designed by the writer for the proof of guns by measurement, was illustrated by diagrams, and the writer stated, that with care, a skilful manipulation might always detect a difference of only one ten-thousandth part of an inch. During the competitive trials of the special committee, at Shoeburyness, in 1864, the writer designed this instrument for ascertaining the alteration which took place in the bore of the 70-pounder gun under trial. The measurements, which were carefully taken during the firing of nearly 3,000 rounds, showed that the enlargements of the bore with successive charges of 10lbs. of powder and 70-lb. shot were regular, and were due entirely to wear of the gun in the powder chamber; but when the powder charge was increased, and a large air space left, the gun being loaded each time with a number of shot, the enlargement of the bore was so rapid, that a continuance of these charges must have led to the destruction of the gun. The instrument invented by the writer afforded the means of carrying out, in the testing of guns, the principle adopted in testing girders, by which any risk from undue strain was avoided.

Mr. J. Ramsbottom, Crewe, read a paper describing an improved Reversing Rolling Mill, which has been in operation for seven months' at the steel works of the London and North-Western Railway Company, at Crewe. The special point in the arrangement is, that the rolls are driven direct by the engine, without the intervention of a fly-wheel, and the engine and rolls together are reversed each time that a heat is passed through, the rolling being alternately in opposite directions. The idea of reversing a train of rolls by reversing the engine at each passage of the heat through the rolls, was first suggested by Mr. Nasmyth, but this is the first attempt to carry the idea out into practice. The engines employed are direct-acting and horizontal, coupled at right angles. They are reversed without shutting off the steam, by hydraulic power. The reversing shaft is connected by links to a piston working in a small cylinder, and the admission of water to the cylinder, regulated by a slide valve worked by a shaft and hand lever, placed in such a position, that the attendant can see the proper moment for reversing. This shaft is hollow, and there runs through it a second shaft, which regulates the main steam valves of the engines. The attendant being in full view of the rolls, has complete command over the mill. The boiler is here the accumulator of power instead of the fly wheel, and the rolling power is conserved a constant, throughout the operation. This mill has been reversed seventy times in a minute without difficulty, and labour and time economised correspondingly. When a slab has entered and passed once through the rolls, the engines are reversed, the hydraulic ram rises, causing the tightening-down screws to descend and lower both ends of top roll simultaneously, to required extent. This is repeated after each passage of a slab. When the rolling is complete, the water is released from the ram which falls, and a counterbalance weight, winds up the tightening screws to their original position. In order to facilitate the introduction of large slabs between the rolls, a set of bent levers is attached to a horizontal shaft which runs along the ground parallel to the rolls. By means of a hand lever, these are simultaneously brought under the slab, which is thus lifted up to the rolls. The rolls are in motion only when the metal is being passed through, it is therefore not necessary for a stream of water on the bearings, and grease is found a sufficient lubricator. Much interest was taken by the members present in the reading of this valuable paper, and in the rather long discussion which followed after.

On Wednesday, the first paper read was "On Boiler Explosions and their Records, and on Inspection as a means of Prevention," by Mr. Edward B. Marten, of Stourbridge. The paper was most elaborate, and, with the aid of diagrams, a description was given of all the known forms of boilers, with representations of the kinds of rupture they had undergone. The records of boiler explosions, as gathered from each year of the present century, showed that no fewer than 1,046 had occurred, causing the deaths of 4,076 persons, and injury to 2,903. Of the 1,046 explosions, 397 were uncertain as to the cause; 137 were from over-pressure, from safety-valves being wedged or over-weighted, or from other acts of carelessness; 119 from collapse of internal flues; 114 from shortness of water, or from incrustation; and 9 from extraneous causes, as lightning, fire, and explosion of gas. The writer was opposed to all idea of internal detonation, or other mysterious causes of explosion. The first real cause he held to be fault in the boiler, arising from bad shape, bad stays, bad material, or bad workmanship; the second mischief arising during working, either from wear and tear, over-heating, shortness of water, accumulation of scurf, corrosion, flaws or fractures in the material, or undue pressure through want of sufficient escape arrangements. He recommended that boilers should not be covered by brickwork, &c., which often concealed the corrosion going forward, but that they should simply have a light roof. He had known five boilers which had been so much

injured by having sand* put upon them, that they had to be re-plated on their upper sides. Many portions of ruptured plates, of various forms, were exhibited, some being attributed to corrosion, others to unequal expansion, or to constant vibration at the angles, which tended to a complete circular stripping out of the ends. The evils arising from incrustation from bad water, were also pointed out, and the use of good water recommended, if even at an increase of cost. An interesting discussion ensued, in which many of the members took part; and a vote of thanks was cordially awarded to the author of the paper, for his great labour and research.

The Secretary read an historical treatise, "On the Preparing and Spinning of Cotton," by Mr. John Platt, M.P., of Oldham.

A paper by Mr. W. Fairbairn next occupied attention. It gave a description of the means employed for "Removing to a new position, the Iron Columns of a fire-proof Cotton Mill in Manchester." These alterations were rendered necessary in some old mills, in order to admit of the new and improved machinery, now in use in the cotton trade. The new columns were first fixed, before the old ones were cut out, and all the floors were made secure. New wrought-iron beams were fixed under the cast-iron wall beams, and upon these were raised the new lines of columns, through six floors, to the top of the mill. The new columns being fixed, a temporary prop was placed under the middle beam, for the support of the arch above, until the brackets could be attached for their final support. By the plan adopted, the process was entirely free from risk, and was conducted from the top storey downwards, until the whole of the floors were placed on new foundations. The work had been carried out at Messrs. M'Connel and Co.'s mill, Union-street, Ancoats, by Mr. Andrew Ker, while the works were in full operation, with several hundred hands employed.

The next paper was "On an Improved Mode of Manufacturing Steel Tyres," by Mr. John Ramsbottom, superintendent of the London and North-Western Railway Company's engineering works at Crewe. The writer stated his object to be the reduction of waste material in the process, to an insignificant amount, compared with the weight of the ingot of steel employed, and for ensuring the production of finished tyres of the dimensions required. A third advantage sought, was the reduction of the time hitherto necessary in the operation. The ingots were made for Bessemer steel, cast in conical moulds, 22in. diameter at the base, and 22in. high, the apex of the cone being cut off at 6in. diameter, and thus forming the opening for filling the mould. This was sufficient to make a 5-ft. tyre. The moulds are of cast-iron, protected in various ways, the centre of the base being covered with fire-clay, which can be readily renewed. The ingot is then first hammered laterally, all round the lower edge of the cone, to consolidate the skin of the metal, after which it is forcibly hammered in the direction of its axis, and reduced to 9in. in height, with a 10-tons duplex hammer—or two hammers, each of this weight, meeting horizontally. The ingot, during this powerful treatment, is supported upon a carriage, and can be readily made to rotate, as required. At a further stage, a hole is punched in the centre, to form it into a ring, this centre opening being gradually enlarged, by a conical punch and the aid of a beck-anvil. When the bloom is brought to 34in. diameter, and the centre hole to 19in. diameter, it is then removed to a circular rolling-mill, which was invented by Mr. Rothwell Jackson, a member of the institute, where it is rolled into a finished tyre, both outside and inside; the latter operation is completed in one heat, of about 5¼ minutes. The whole process from the cast ingot, is accomplished in four heats, and it was stated that on one occasion six tyres were made in 5 hours and 12 minutes. The quality of the steel is believed to be improved in the operation.

The last paper was contributed by Mr. John F. Bateman, of London, "On the Manchester Waterworks." It was stated that the drainage ground extended over 19,000 acres, and in parts had an elevation of 1,800ft. above the level of the sea, and supplied some of the purest water in the world. The average rain-fall was 50in., and the amount collectable 40in. per annum. There was an available supply of 26 million gallons. In times of flood the water became turbid, but this water, by an ingenious self-acting contrivance invented by Mr. Moore, an assistant to Mr. Bateman, was separated and stored, while the pure water was conveyed direct to Manchester. When there was a flood, and the water consequently turbid, its velocity caused it to shoot over a narrow aperture, into which it would at other times fall, thus causing an important separation. The reservoirs, with the arrangement for working the sluices at different points, were explained pictorially and otherwise; but, Mr. Bateman being unavoidably absent, several questions could not be fully answered, but are to be supplied.—This concluded the reading of papers for the present session.

The members and friends visited the steel-works of the London and North-Western Railway, at Crewe; various engineering establishments in Manchester and the neighbourhood; the Whitworth Gun Factory; the works of Messrs. Platt, Brothers, Oldham; the works of Messrs. Beyer, Peacock, and Co., Gorton; and of the Ashbury Company (Limited), Openshaw. The members were invited, on Friday, by the President, to his residence, Stancliff Hall, Derbyshire, which concluded the programme. It is thought likely that next year's meeting may be held in Paris.

*It is well-known fact, that sand acts destructively on iron, but it is preservative of wood; the more so, in both cases, in the presence of moisture.—Ed. A.

CHEMICAL SOCIETY.

THE PLATINUM-BASES: THE BEST MODE OF OBTAINING AND IDENTIFYING THEM; SOME NEW COMPOUNDS.

By EDWARD ASH HADOW, King's College.

On first attempting to prepare the platinum-bases as specimens for Dr. Miller's lecture table, I encountered various perplexing difficulties, arising from the endless number of compounds that could be formed, and I felt the want of ready methods for recognising the class to which any unknown salt belonged, whether platosamine or diplatosamine, platinamine, or diplatinamine, or chlorodiplatinamine, as Gros' or Raewsky's salt. The source, too, of all these salts is always the green salt of Magnus, the preparation of which, in any quantity, is attended with the greatest uncertainty, and if too much sulphurous acid has been used to reduce the bichloride of platinum, is often a total failure. Then again, when it is obtained and used for forming Gros' and Raewsky's nitrate, half the platinum is wasted as chloride or nitrate. Disheartened by such a mode of proceeding, I determined to proceed by an entirely different method, and to convert a certain weight of metallic platinum into its equivalent of pure dry protochloride by heat in the usual manner. When the protochloride thus obtained is digested in warm moderately strong ammonia, it dissolves gradually but completely, excepting a little iridium and oxide of iron, giving a brownish solution. On filtering and concentrating, a large crop of fine prisms of hydrochlorate of diplatosamine is obtained, which is the source of all the other bases. These crystals contain an atom of water, N_2H_6PtCl,HO, which is not usually given in books, and which, to my cost, I did not discover for some time, and graduating my permanganate solutions by the salt as if anhydrous, I met with most perplexing results.

Gros' nitrate ($N_2H_6PtClO.NO_5$) is obtained from this salt by pouring a hot solution of it into hot, moderately concentrated nitric acid; abundance of red fumes are evolved, and a thick paste of small crystals of Gros' nitrate forms at the bottom of the acid, in which it is almost insoluble; it can be drained on asbestos, and dried at about 280° Fahr.; when recrystallised from water it gives brilliant flat prisms.

Raewsky's nitrate is obtained easily and abundantly from Gros' salt by boiling the latter for some hours with nitrate of silver and some nitric acid; but no excess of nitrate of silver can remove the chlorine from Raewsky's nitrate, and reduce it to a nitrate of diplatinamine, from which it differs totally in all its properties; analysis completely confirms the correctness of Gerhardt's formula for Raewsky's nitrate, $N_4H_{12}Pt_2ClO_3.2NO_5,HO=442$.—Raewsky's own formula, $N_4H_{12}Pt_2ClO_5.2NO_5$ is obviously impossible, Pt_2 being brought to the platinic state by $Cl + O_3$, leaving O_2 in excess. The above being the formula for Raewsky's nitrate, its derivation from Gros' nitrate by nitrate of silver is simple enough; 2 atoms of Gros' nitrate unite, and losing an atom of chlorine, gain one of oxygen—

$$2(N_2H_6PtClO.NO_5)+AgO.NO_5+HO=N_4H_{12}Pt_2ClO_32NO_5+AgCl+HO.NO_5,$$

so that 2 atoms of Gros' nitrate, or 462 parts, require 1 atom of nitrate of silver for the decomposition; but in practice it is better to use rather more, or about 190 parts of the nitrate of silver. After filtering from chloride of silver, it is well to boil the solution again, to make sure that the transformation is complete. After the decomposition has ceased, the filtered solution is somewhat concentrated by evaporation and allowed to cool, when Raewsky's nitrate crystallises abundantly; it can be treated as Gros' salt, washing away the solution of nitrate of silver with diluted nitric acid, and drying at 280° F.

From the singular proportion that exists between the acid and the oxygen in Raewsky's nitrate, I had the curiosity to ascertain what the composition of the hydrochlorate would be, and therefore added chloride of ammonium in excess to Raewsky's nitrate, collected the precipitate of minute prisms thus produced, and washed with alcohol till clean. The hydrochlorate was found to have the composition $N_4H_{12}Pt_2Cl_3O$.

With regard to discovering the class to which a base belongs, platosamine and diplatosamine salts correspond, in their reducing action on permanganate of potash, to the protochloride of platinum, from which they are derived. The diplatosamine-salts are readily recognised by their property of yielding Magnus' green salt when treated with a solution of protochloride of platinum. Magnus' green is only one of a large series of double salts that hydrochlorate of diplatosamine is capable of forming with other metallic chlorides, such as corrosive sublimate and the chlorides of cadmium, palladium, tin, and copper. The double salts formed with cadmium and with mercury were analysed, and found to have the same composition—1 atom of each salt. The diplatosamine salts are further characterised by the beautiful blue or green precipitate or solution, which they furnish when a current of nitrous acid is passed into their strongly acidified solution. None of these reactions are exhibited by the platosamine salts, which possess little interest.

The diplatinamine, chlorodiplatinamine, and platinamine salts have, of course, no reducing action on solutions of the permanganates. The two series of most interest, viz., those of Gros and of Raewsky, are readily distinguished. Chloride of ammonium gives with the salts of Gros' series, an insoluble, and with those of Raewsky's, a soluble chloride; a single drop of solution of sulphate of soda with a drop of solution of Gros' nitrate, on stirring, gives hairy tufts, which are deposited on the lines of stirring, but no change occurs when Raewsky's nitrate is similarly treated. But the most characteristic reaction of Raewsky's nitrate is that of giving, with a very dilute solution of protochloride of platinum strongly acidulated with nitric acid, a beautiful, coppery, moss-like precipitate, exactly resembling in appearance the platinidcyanide of potassium; Gros' nitrate has no such reaction.

The diplatinamine-salts are quite uninteresting; they give with chlorides, after some time, large crystals of the hydrochlorate; they may readily be recognised by being reduced by sulphurous acid to salts of diplatosamine, whereas platinamine salts, by the same agent, are reduced to salts of platosamine.

The reaction between nitrous acid and acidulated salts of diplatosamine seems most singularly to have been overlooked. I have examined two of the compounds, one of which is blue and the other green. The blue compound is obtained with nitrate of diplatosamine (obtained from the hydrochlorate by double decomposition with nitrate of silver), by acidulating its solution strongly with nitric acid, and passing in nitrous acid vapours. A beautiful smalt-blue precipitate then falls in abundance, which, under the microscope, is seen to consist of dodecahedrons. The green precipitate is less beautiful, and is obtained

by passing nitrous acid into hydrochlorate of diplatosamine strongly acidulated with hydrochloric acid. These precipitates can be drained on asbestos and afterwards washed with dilute hydrochloric and nitric acids respectively; they may be dried without visible change at 212°. Some very simple experiments served to show qualitatively the composition of these precipitates. Placed in pure water, both precipitates soon dissolve, furnishing blue and green liquids respectively, smelling strongly of nitrous acid; on gently warming, the nitrous acid goes off, leaving unchanged diplatosamine-salts strongly acid with hydrochloric and nitric acids. If, instead of expelling the nitrous acid by heat, the corresponding acids be added to each solution, the original precipitate will be obtained unaltered. These precipitates appear, therefore, to consist, the blue of nitrate of diplatosamine with nitric and nitrous acids, and the green of the hydrochlorate of diplatosamine with hydrochloric and nitrous acids. The nitrous acid manifestly acts in these compounds the part of a base, nor is this the only instance in which it appears to do so. In the crystalline body of the leaden chambers, $NO_3 \cdot 2SO_3$, as well as in Frémy's sulphammonates, it appears to act a basic part; further, the analogy between SbO_3 and NO_3 would lead us to expect in the latter signs of a basic character. Peroxide of nitrogen has all the characters of a nitrate of the oxide NO_3. It may be well to mention here that the instability of nitrous acid is in most chemical works greatly over-estimated, it being stated to be instantly decomposed by water. My own experience indicates quite the reverse, and if the water be acidulated, the nitrous acid appears to be remarkably stable.

These nitrous compounds were analysed by determining the amount of platinum in each, and then, by means of standard permanganate, determining the amount of oxygen capable of being absorbed. One atom of platinum (99), as diplatosamine, can only take up 1 atom (8) of oxygen. All absorbed beyond this is due to nitrous acid.

The blue nitrate dried at 212° gave 40·8 per cent. of platinum, and in one experiment it was found capable of absorbing 15·06 by weight of oxygen, for every one atom of platinum (99), evidently pointing to 16 parts, or 2 atoms, of oxygen; but as 1 atom of nitrous acid absorbs 2 atoms of oxygen, there can be only 1 atom of nitrous acid present to 2 atoms of platinum as diplatosamine; this points to the formula

$$\left\{ \begin{matrix} 2(N_2H_6PtO.NO_5) \\ NO_3.NO_5 \end{matrix} \right\} = 482,$$

which is sufficiently confirmed by the following percentages:—

	Found.	Calculated from Formula.
Oxygen absorbable =	6·2	6·6
Platinum =	40·8	41·0

As a further confirmation, the percentage of nitrogen was determined volumetrically, and found to be 80·48 cubic inches per 100 grains of blue nitrate. Reduced to weight it gives—

	Found.	Calculated.
Nitrogen.........	24·3	23·2

The green hydrochlorate appears under the microscope as feathery stars, not so readily soluble in water as the blue nitrate. The formula of the blue nitrate at once suggested that of the green hydrochlorate, namely:—

$$\left. \begin{matrix} 2N_2H_6PtCl \\ NO_3HCl \end{matrix} \right\} = 412;$$

which was sufficiently confirmed by analysis.

	Found.	Calculated from Formula.
Platinum	= 48·8	47·94
Chlorine	= 26·07	26·15
Oxygen absorbable	= 7·51	7·74

It was a far more difficult task to determine the composition of the coppery precipitate given by Raewsky's nitrate with an acid solution of protochloride of platinum. Qualitative experiments tell much with regard to it.

The following facts are readily ascertained:—

1. Boiled in water, it is resolved into Magnus' green, Gros' nitrate, and protochloride of platinum—the two latter in equal number of atoms.

2. The proportion of platinum to chlorine is one atom of each, just as in the green compound of Magnus.

3. If a reducing agent, such as sulphate of iron, be added to the solution, instead of boiling the liquid, the quantity of Magnus' green is sensibly increased, owing to the reduction of Gros' nitrate to hydrochlorate of diplatosamine, which, with the protochloride of platinum present, occasions the additional amount of the green precipitate.

4. These reactions plainly point to a formula of this kind $x(N_2H_6Pt_2Cl_2)O.NO_5$. The difficulty has been to find the value of x, and this has been due to the excessive uncertainty of the composition of the various samples of the coppery body, as is shown at once by ascertaining the percentage of platinum, which varies from 62 in the worst to 56 in the best looking product.

Then, again, it was found difficult to bring the salt into solution unchanged in composition for graduation by permanganate. This appears to be best effected by digesting the compound in a solution of Raewky's nitrate containing excess of dilute sulphuric acid. Determinations of the proportion of platinum in the platinic state have given numbers varying from 1 in 6 of total platinum in the best, to 1 in 10 in the worst. From these uncertain results I am only able to give a theoretical formula, being prevented from making any further experiments for some time to come; but of the correctness of the formula I feel pretty confident.

Theoretical composition of the coppery salt—

$$\left\{ \begin{matrix} 5(N_2H_6Pt_2Cl_2) \\ N_2H_6Pt_2Cl_2O_2.2NO_5 \end{matrix} \right\} = 1940;$$

it is thus seen to have a similar composition to that of the platinid-cyanides*

$$\left\{ \begin{matrix} 5(KCy.PtCy) \\ KCy.PtCy.Cl \end{matrix} \right\},$$

$\frac{5}{6}$ of the platinum in each being in the platinous, and $\frac{1}{6}$ of each in the platinic state. The decomposition by boiling in water would be—

$$5N_2H_6Pt_2Cl_2N_2H_6Pt_2Cl_2O_2.2NO_5 = 2(N_2H_6PtO.NO_5) + 2PtCl_2 + 4N_2H_6Pt_2Cl_2$$

All the experiments alluded to were made with the coppery salt, prepared by mixing Raewsky's nitrate with a solution of protochloride of platinum highly acidified with nitric acid; a far better method, more easy, more profitable and more sure, has only lately been discovered. This consists in immersing the green compound of Magnus for some hours in a highly dilute solution of Raewsky's nitrate strongly acidified with nitric acid, and in large excess; the green salt then expands greatly in bulk and becomes brilliantly coppery. A brilliant sample of this salt gave 59·2 per cent. of platinum; the above formula requires 60·9. On boiling the product in water, the green compound of Magnus which was formed contained platinum equal to 40 per cent. of the weight of the salt, thus corresponding exactly with the decomposition which occurs when the copper-compound is simply boiled with water, in which case $\frac{4}{6}$ of the platinum separates as the green salt of Magnus.

In the formation of this coppery salt, by the above method, a rather singular decomposition of Raewsky's nitrate occurs thus—

$$N_4H_{12}Pt_2ClO_3.2NO_5 - O = N_2H_6PtO.NO_5 + N_2H_6PtClO.NO_5,$$

or by the loss of an atom of oxygen, which it imparts to the Magnus' green, it is reduced to equal numbers of atoms of Gros' nitrate and nitrate of diplatosamine. Sulphate of soda will show the presence of the former, and nitrous acid that of the latter salt. The same reaction can be shown in another way. Raewsky's nitrate and sulphate of soda may be left mixed without change; but on adding a small quantity of a reducing agent, such as proto-sulphate of iron, the characteristic crystals of Gros' sulphate appear in a few minutes.

The singular composition of these coppery bodies seems to point towards the existence of an oxide of platinum having the composition Pt_6O_7. I have not as yet obtained any proof of its existence, but I cannot help thinking it will one day be indicated by some characteristic of colour or form, &c., distinguishing it from the protoxide and peroxide.

There are one or two isolated facts which I may as well insert here by way of conclusion. On one occasion wishing to prepare the green salt of Magnus, protochloride of platinum was prepared with sulphurous acid as usual, the solution was divided into equal parts, and one-half was converted into hydrochlorate of diplatosamine by ammonia and mixed with the other half, when, instead of the usual green, a dove-coloured precipitate fell; it was not altered by boiling, simply dissolving and crystallising out of the same colour. On determining the platinum, it corresponded perfectly with that in the green compound—

Green compound gave Pt = 64.3
Dove-coloured compound, Pt = 64·62

On boiling in hydrochloric acid, however, it became quite green, and on testing with zinc and hydrochloric acid, sulphuretted hydrogen came off directly, proving the presence of sulphurous acid. To determine the amount of sulphurous acid, the dove-coloured salt was dissolved in ammonia and graduated by permanganate. It was found that for every 2 atoms of platinum $2\frac{1}{2}$ atoms of oxygen were absorbed, which points to a formula for the dove-coloured salt =

$$\left\{ \begin{matrix} N_2H_6PtCl \\ PtCl \\ N_2H_6PtCl \\ PtO.SO_2 \end{matrix} \right\}$$

I must also here remark that, since writing this paper, I have looked into Graham's "Chemistry" on nitrous acid, and I was not a little gratified to find that he ascribes to nitrous acid a thoroughly basic character, a view I had not noticed in his or other works.

HIRE AND WHITE'S PATENT LIFE-BOAT BRIDGES.

This invention has for its object to facilitate the various operations to be performed on board ships above deck by employing a number of Lamb and White's well-known watertight lifeboats as a "bridge" and arranging them in such a manner as to enable them being launched at a moment's notice, and to be employed for saving life at sea in case of shipwreck, fire, &c., or for the transport of men and materials, landing of passengers, troops, ordnance, or for other similar purposes.

The boat is mounted athwart the ship's deck, as a bridge," on a platform which is nothing more or less than a set of launching ways, the keel of the boat fitting in a groove, and the bilges of the boat resting on the side "ways." These "ways" are pivoted in the centre on stout stanchions, and their ends are held in position over the ship's hammock netting on each side by screw stanchions. The ship's bulwarks next these screw stanchions are cut into a large port on each side rather wider than the boat, and when open throw outwards. If the boat has to be lowered, the screw stanchions are lowered on the side required, the port opened, and the boat on its ways lowered down until the lower end of the ways rest on the ship's side over her waterway. The striking up then of an ordinary dogshore releases the boat, and sends her off and afloat alongside the ship. In getting her in again two threefold tackles, from davits fixed at each end of the ways, lift

* Chem. Soc. J. vol. xiii, 1861, p. 113.

one end of the boat on the lower end of the inclined ways; another tackle from their further end hauls the boat into its seat; the ways and the boat are then swayed into position again, screw stanchions are set up and fastenings made good, and the whole has now become a bridge again. The boat is thus got in and out of the ship without any purchase from her masts and yards. The platform of the bridge is formed of properly fitted planking laid over the boat's thwarts, and left on board the ship when she is sent afloat.

In the accompanying wood engravings illustrating this invention, Figs. 1 and 2 represent a longitudinal view and a plan of the framing, as fitted

Fig. 1.

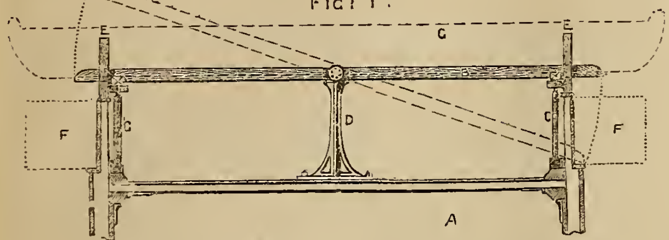
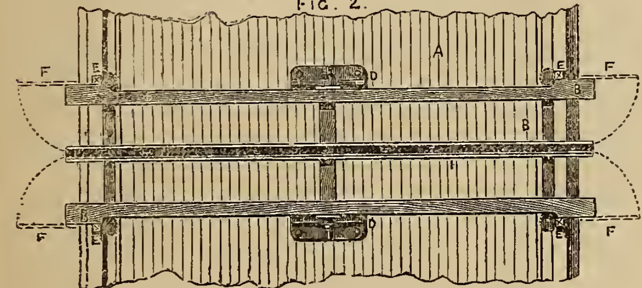
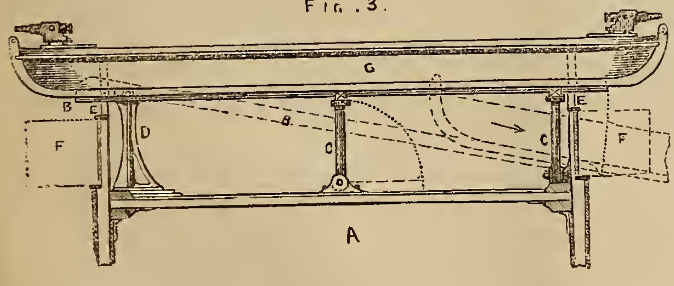


Fig. 2.



on board a ship, the first round which the framing will oscillate, on being inclined, being placed in its centre, while in Fig. 3, showing a similar longitudinal view, the first is placed at one of the two extremities of the framing. In this view a lifeboat is shown in position above the frame. Figs. 4 and 5 show two arrangements of lifeboat bridges in plan; in these views either three or four lifeboats are connected together. In all these five figures the following letters of reference are used throughout to denote respectively.

Fig. 3.



A the body of the ship or ship's hull.

B the wooden frame, its horizontal position being shown in full, and its inclined position in dotted lines Figs. 1 and 3.

C C, stanchions at extremities of the two end tie-pieces of framing (Fig. 1) or of the central and one end tie-piece (Fig. 3.)

D D, supports for pivots of framing, respectively, or midship (Fig. 1) or at port or starboard (Fig. 3).

E E, uprights for guidance of frame.

F F, ports opened at 90 degrees at the moment of launching the life-boats.

G G, lifeboats in position.

H, Figs. 1, 2, and 3 central rail for guidance of keel of life-boat.

It is to be hoped that this and similar plans for the increase of life-boat accommodation on board sea ships, will receive due attention and a fair trial on the part of the owners of private ships, and chiefly the authorities of our dockyards. The shameful neglect of adequate provision for ship-wrecks, or of destruction by fire at sea, both on the part of steam ship-owners and those engaged in the transport of emigrants, as well as the transport department of H.M. Admiralty, cries loudly for redress. The recently reported total loss of the *Monarch of the Seas*, with many hundred lives on board, is a terrible illustration of the pressing necessity of some legislative enactment by which it would be made penal to omit

Fig. 4.

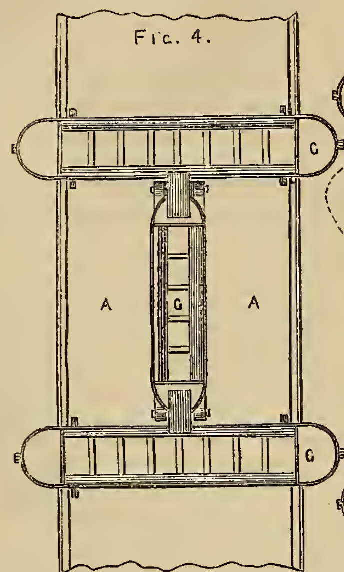
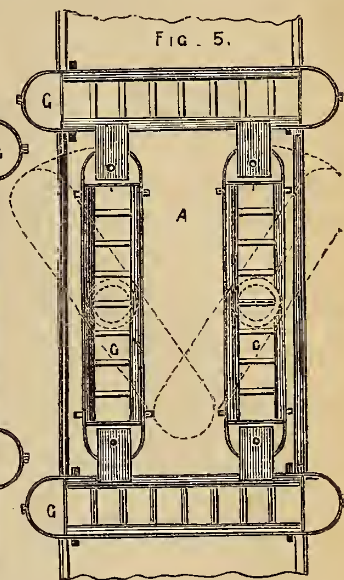


Fig. 5.



providing sufficient lifeboat accommodation, with food and water for several days' consumption for the passengers and crew of all sea ships. In the recent case of the *Amazon*, the boats were so crowded that the whole of their living freight would have perished, had there been any sea running at the time, and had any breeze sprung up. A radical change in the passive attitude hitherto observed by our naval authorities, in a matter affecting the lives of thousands and thousands, is a "consummation devoutly to be wished."

THE NEW VICTORIA BRIDGE.

This new bridge is completed and open for traffic. It spans the Thames at Battersea. It has been inspected by Captain Rich for the Board of Trade. Eight of the heaviest engines of the London, Chatham, and Dover Railway Company gave a greatest deflection of seven-eighths of an inch on a span of 175ft. The simultaneous rise of the corresponding ribs was but one-eigth of an inch. The length of this bridge is 912ft. and its width is 132ft. It is the widest railway bridge that we know. It consists of four river spans of 175ft. in the clear, and two land spans of 65ft. and 70ft. respectively. The spans and rise are the same as those of the original bridge hitherto used jointly by the two companies for whom the present work has been undertaken—the London, Chatham, and Dover and the London, Brighton, and South Coast Railway Companies—but the foundations and the ironwork are perfectly distinct. The great additions made to the capabilities of the two companies can be appreciated when we state that the bridge holds two mixed guage, and two narrow guage lines for the London Chatham, and Dover line, and one for the London, Brighton & South Coast. Besides, there is a space of 33ft. 6in. for the up and down platforms, which is so arranged as to be available hereafter by a small additional expense, for three more narrow guage lines; so that, altogether, with those already in operation on the elder bridge, there will be ten separate means of access to the Victoria Station, each having a distinct and independent approach. The bridge forms the key to the intricate network of high level lines at Battersea, now nearly completed, and facilitate the traffic there. The 32 arch ribs in the four spans are so arranged, as to act as cantilevers while the horizontal girder connected with them by spandrils is rivetted up, and thus forms one continuous girder from end to end of the bridge, which, as has been stated, is 912ft. in length. Again the ribs abut on cast-iron skew-backs, from which, on the piers, cast-iron standards are carried up to support the horizontal girder; so that the bridge is, in fact, an uninterrupted structure of iron, without the intervention of masonry or brickwork of any kind. The cylinders beneath have been fitted with concrete in cement a brickwork, loaded with pig-iron, so as to equal the weight of the superstructure when occupied with locomotives. In those next the elder bridge the weight was 1,260, and in the others 1,000 tons. The greatest settlement in any

part of this structure was not more than ⅜ths of an inch. The works connected with the bridge on the south side of the river are chiefly lofty viaducts, representing a total length of ten miles of double lines. There will be four new stations—namely, Grosvenor-road, York-road, Battersea-road, and Queen's-road, thus affording corresponding facilities for passengers and traffic. Considering the magnitude of the work it has been accomplished in a very short time. The foundation was laid in February, 1865, and the Government inspection took place in August, 1866. The Chatham Company's portions of the work, and also the South-Western Company's have been constructed by Messrs. Peto and Betts; the Brighton Company's branches by Messrs. Pickering and Heywood; Sir Charles Fox and Sons being the engineers and superintendents of the whole.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

With the opening of the week began the more immediate preparations for the thirty-sixth annual meeting. There were no less than 600 names of members recorded on Monday, the 20th August, 1866, with local addresses. The town itself is interesting in its irregularity, in the arrangement of streets, and form, and style, and age of the houses. Nearly £4,000 had been subscribed for the entertainments and the preparations for the grand *soirée* in the exhibition building were made on a scale of more than mediæval magnificence. The excursions, more numerous than customary, were prepared with unusual care, and include some lovely as well as instructive and interesting scenes—Nuthall, Newstead Abbey, the Annesley Works, Eastwood, the Riding's Colleries and Alfreton Iron Works, the Midland Railway Works at Derby, Charnwood Forest, the Butterley Company's Works, the valleys of the Derwent and the Wye, and Belvoir Castle, under able guides. In the town itself the great lace factories were all thrown open, and makers of hosiery opened their doors.

The objects of the British Association are to give a stronger impulse and more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British empire with one another and with foreign philosophers, to obtain more general attention to the objects of science, and the removal of any disadvantages of a public kind which impede its progress. Time was when the sturdy pioneers of scientific investigation had to pursue their researches and labours in the solitary garret, or the cloistered cell,—well for them if it were not actually within the prison walls. But in these days professors are not only free to study as they list, but when they meet, once a year or oftener, in the light of day and on the public platform, to exchange greetings, and to discuss the progress made since their last muster, society rises to do them honour, fêtes are organised, and wherever they go they are welcomed and lionised. This year circumstances led the association to visit Nottingham. The peculiar character of the industrial manufactures, the close proximity of large mining and other important works to the town, and the interesting geological features of the surrounding district, all justify the choice which the Association made of a place of meeting this year.

The great hall of the Exchange, a room 75ft. long, 30ft. wide, and 35ft. high, beautifully decorated, and used ordinarily for a variety of purposes, such as concerts, was devoted during the stay of the *savants* to the purposes of a central refreshment-room. A successful engagement at the theatre has been interrupted to provide an area sufficiently large for the evening meetings and lectures of the fortnight. Probably the preparations at the Working Men's Exhibition Building are entitled to rank as the most meritorious feature in the general arrangements. This building, which originally was only intended to be temporary, has been secured for the town, and fixed upon as the place where two *soirées* were held. The walls of the gallery were covered with paintings, photographs, &c., lent by gentlemen resident in the neighbourhood, and to the original building an *annexe* was added, in which the elaborate arrangement of artificial rockwork and cascades, flowers, shrubs, and ferns, when illuminated by the electric light afforded much pleasure to the guests of the evening.

On Wednesday the 22nd ult. at 1 o'clock, the formal proceedings of the meeting commenced by a meeting of the general committee held in the Mechanics' Hall, under the presidency of Professor Phillips, when a preliminary report was read from the Council, and also reports from the treasurer, the Kew, and Parliamentary Committees. The Kew Committee in their report cordially acquiesced in the suggestion that the establishment at Kew should be developed so as to become a meteorological centre of observation, in place of perpetuating the present system. The Parliamentary Committee in their report expressed regret that another session had been allowed to pass without any step being taken by the Legislature to promote the study of science in our great public schools. They referred, however, to the act passed to amend the acts relating to the imperial standards of weight, measure, and capacity, as one which would effect very useful reforms in the constitution of the office having the custody of the imperial standards, whereby the organisation of the department would be placed on a more scientific basis. Regarding the meteorological department of the Board of Trade, the Report said, "Your committee will not fail to advocate such measures as may be necessary for placing this department on a satisfactory footing.

The concluding recommendation that Sir Henry Rawlinson be elected a member of the committee, was, of course, complied with.

To the list of corresponding members the names of the following foreign men of science, who attended the Birmingham meeting, were added:—

Captain Belavenetz, Geheimrath von Dechen, M. Gaudry, Professor Grube, Professor Kiepert, Professor F. Römer, Chevalier C. Negri, and Professor Steenstrup. Those of Mr. J. Hind, F.R.S., and Mr. T. Close were added to the list of vice-presidents and to fill the place vacated by the resignation last year of Mr. Hopkins as joint general secretary. Mr. Thomas Archer Hirst, Ph. D., F.R.S., Professor of Mathematical Physics, University College, London, was unanimously choosen.

Incidentally it was mentioned that invitations for future meetings of the Association had been received from Dundee, Norwich, Plymouth, and Exeter.

The following is the address of the President, Mr. Grove, Q.C.

Mr. Grove said that if their rude predecessors who at one time inhabited the caverns by which Nottingham was surrounded could rise from their graves and see the town in its present state it might be doubtful whether they would have sufficient knowledge to be surprised at what they witnessed. The machinery, almost resembling organic beings in delicacy of structure, by which were fabricated products of world-wide reputation; the powers of matter, applied to give motion to that machinery, were so far removed from what must have been the conceptions of the semi-barbarians to whom he alluded, that they could not look upon those things with intelligent wonder. Yet that immense progress had all been effected step by step; nor was it in those branches of natural knowledge only which tended to improvements in economical arts and manufactures that science had greatly advanced. To assert that the great departments of Government should encourage physical science might appear a truism, and yet it was but of late that it had seriously been done. Now, the habit of consulting men of science on important questions of national interest was becoming a recognised practice, and a more definite sphere of usefulness for those duly qualified men who might be content to give up the more tempting study of abstract science for that of its practical application, would, be had no doubt, in time be provided. In that respect the Report of the Kew Committee for the present year had afforded a subject of congratulation. The Kew Observatory, the petted child of the British Association, might possibly become an important national establishment, and if so, while it would not, he trusted, lose its character of a home for untramelled physical research, it would have superadded the Meteorological Department of the Board of Trade with a staff of skilful and experienced observers. That was one of the results which the general growth of science, and the labours of the British Association in particular, had produced; but he did not, on that occasion, intend to recapitulate the special objects which they had succeeded in attaining. One word would give the key to his discourse; that word was continuity. The more they investigated, the more they found that in existing phenomena graduation from the like to the seemingly unlike prevailed, and that in the changes which took place in time, gradual progress was, and apparently must be, the course of nature. Let him endeavour to apply that view to the recent progress of some of the more prominent branches of science. In astronomy, from the time when the earth was considered a flat plain, bounded by a flat ocean, each successive discovery had brought with it similitudes and analogies between the earth and many of the objects of the universe with which our senses, aided by instruments, had made us acquainted. Passing over the establishment of the Copernican system, he might remark that the proofs that gravitation was not confined to our solar system, but that it pervaded the universe, had received many confirmations from the labours of members of the Association, among others of Lord Rosse, Lord Wrottesley, and Sir John Herschel, the two latter of whom had devoted special attention to the orbits of double stars, the first mentioned to those probably more recent systems called nubulæ. There was, however, another class of observations, quite new in its importance, which had formed a special subject of contribution to the reports of the Association—he alluded to those on meteorites, at which their lamented member, Professor Baden Powell, assiduously laboured. It would occupy too much of their time to detail the efforts of Bessel, Schwinke, the late Sir J. Lubbock, and others, as applied to the formation of star charts, for aiding the observation which Mr. Alexander Herschel, Mr. Brayley, Mr. Sorby and others were now engaged in studying. As it was, there was evidence almost amounting to proof that those meteors were cosmical bodies moving in the interplanetary space by gravitation round the sun, and some perhaps round planets. That view gave us a new element of continuity. The universe would thus appear not to have the extent of empty space formerly attributed to it, but to be studded, between the larger and more visible masses, with smaller planets, if that term were permitted to be applied to meteorites. Observations were now being made at the periods at which meteors appeared in the greatest numbers,—at Greenwich by Mr. Glaisher, at Cambridge by Professor Adams, and at Hawkhurst by Mr. Alexander Herschel. If, he might add, the same scrutiny were applied to other parts of the heavens as to the zone between Mars and Jupiter, it would be no far-fetched speculation to suppose that between the asteroids or bodies of a smaller size that were known as the ancient planets, of which, instead of seven, we now counted 88, and the meteorites, bodies of intermediate size existed until the space occupied by our solar system became filled up with planetary bodies varying in size from that of Jupiter—1,240 times larger in volume than the earth—to that of a cannon ball or even a pistol bullet. Another half century would not improbably enable us to ascertain that the now seemingly vacant interplanetary spaces were occupied by smaller bodies still which had hitherto escaped notice, just as the asteroids had done until the time of Olbers and Piazzi. But the evidence of continuity as pervading the universe did not stop at telescopic observation; chemistry and physical optics furnished us with new proofs of its existence. These meteoric bodies which had from time to time come so far within the reach of the earth's attraction so as to fall upon its surface gave on analysis metals and oxides similar to those which belonged to the structure of the earth. M. Daubrée, too, as appeared from a series of papers which he had recently communicated to the French Academy, had succeeded in forming from terrestrial rocks, substances very much resembling meteorites, so that a closer relationship, although by no means identity, had been established between the earth and those wanderers from remote regions. But while chemistry, analytic and synthetic, thus assisted us in ascertaining

the relationship of our planet to meteorites, its relation in composition to other planets, to the sun, and to more distant suns and systems, was demonstrated by another science—optics. Chemical analysis by the spectrum, as well as gravitation and physical constitution, pointed out to us that matter had similar characteristics in other worlds than our own; but when we passed to the consideration of those other attributes of matter which were now recognised as forces or modes of motion, we found the evidence of continuity still stronger. What were magnetism and electricity? forces so universal, so apparently connected with matter as to be regarded as two of its invariable attributes. So with light, heat, and chemical affinity; it seemed to him—though as he had taken an active part for a quarter of a century in promoting that view, he might not be looked upon as an impartial judge—that it was now proved that all those forces were so connected *inter se* and with motion that they must be regarded as modifications of each other, and as resolving themselves objectively into motion, and subjectively into something which produced or resisted motion, and which we called force. He might, perhaps, be permitted to recal to the notice of the meeting a forgotten experiment which many years ago he had made at the London Institution, and which appeared to him to be important from the consequences to be deduced from it. A train of multiplying wheels ended with a small metallic wheel which, when the train was put in motion revolved with extreme rapidity against the periphery of the next wheel, a wooden one. In the metallic wheel was placed a small piece of phosphorus, and as long as the wheels revolved the phosphorus remained unchanged, but the moment the last wheel was stopped, by moving a small lever attached to it, the phosphorus burst into a flame. His object was to show that while motion of the mass was continued heat was not generated, but that when arrested, the force continuing to operate, the motion of the mass became heat in the particles. The experiment differed from that of Romford's cannon-boring and Davy's friction of ice, in showing that there was no heat while the motion was unresisted, but that the heat was in some way dependent on the motion being inpeded. We had now become so accustomed to that view that whenever we found motion resisted we looked upon heat, electricity, or some other force as the necessary result. If magnetism, as it was proved to be, was connected with the other forces or affections of matter, it must be cosmical, and not merely terrestrial. One of the most startling suggestions, he might add, as to the consequence resulting from the dynamical theory of heat was that of Mayer, to the effect that by the loss of *vis viva* occasioned by friction of the the tidal waves, as well as by their forming, as it were, a drag upon the earth's rotatory movement, the velocity of the earth's rotation must be gradually diminished, and that thus, unless some undiscovered compensatory action existed that rotation must ultimately cease, and changes hardly calculable take place in the solar system. But our sun, our earth, and planets were constantly radiating heat into space; so in all probability were the other suns, the stars, and their attendant planets. What became of that heat thus radiated into space? If the universe had no limit, and it was difficult to conceive one, there was an incessant evolution of heat and light, and yet more was given off than was received by each cosmical body, for otherwise night would be as bright and as warm as day. What became of the enormous force thus apparently non-recurrent in the same form? Did it move or contribute to move suns and planets? We were not in a position at present to solve the question; but he knew of no problem in celestial dynamics more deeply interesting, and we might be no further removed from its solution than the predecessors of Newton were from the simple dynamical relation of matter to matter which that potent intellect had detected and demonstrated. Passing from extra-terrestrial theories to the narrower field of molecular physics, we found the doctrine of correlation of forces steadily making its way. In a practical point of view, the power of converting one mode of force into another was of the highest importance. At a moment when the prospective exhaustion of our coalfields, somewhat prematurely, perhaps, occupied men's minds there was much encouragement to be derived from the knowledge that we could at will produce heat by the expenditure of other forces. Some experiments in electricty which had been made by Mr. Wilde and Mr. Holtz tended clearly to show that by a mere formal disposition of matter one force could be converted into another: and, as we might at no very distant day need for the daily uses of mankind heat, light, and mechanical force, and find our present resources exhausted, the greater the extent to which we could invent new modes of conversion of forces the better the prospect we should of supplying that want. It was but a month from that time that the greatest triumph of force conversion had been attained. The chemical action generated by a little salt water on a few pieces of zinc now enabled us to converse with inhabitants of the opposite hemisphere of this planet, and

"Put a girdle round about the earth in forty minutes."

In physiology, again, very considerable strides were being made by studying the relation of organised bodies to external forces. The amount of labour which a man had undergone in the course of twenty-four hours might be approximately arrived at by an examination of the chymical changes which had taken place in his body, changed forms in matter indicating the anterior exercise of dynamical force. In dealing with the subject, however, we must not confuse the question of the food which gave permanent capability of muscular force with that which supplied its requisites for temporary activity. The carnivora were, no doubt, the most powerfully constituted animals, but the chamois and gazelle had great temporary capacity for muscular exertion though their food was vegetable. That and many similar classes of research showed that in chymical inquirics, as in other branches of science, we were gradually relieving ourselves of hypothetical existences which certainly had the advantage that they might be varied to suit the requirements of the theorist. The facts, also, which were made known to us by geological inquiries, while, on the one hand, they afforded striking evidence of continuity, might, on the other, owing to the breaks in the record, he used as arguments against it. The physical breaks in the stratification sometimes, no doubt, rendered it next to impossible to fairly trace the order of succession of organisms by the evidence afforded by their fossil remains. Thus, there were nine great breaks in the Palæozoic series, four in the secondary, and one in the tertiary, besides those between Palæozoic and secondary and secondary and tertiary respectively. But, although these breaks existed, there was found pervading the works of many geologists the belief, sometimes avowed, sometimes implied, that the succession of species bore some definite relation to the succession of strata. Indications of the connection between cosmical studies and geological researches, too, were gradually drawing upon us. There was, for instance, some reason to believe that we could trace many geological phenomena to our varying rotation round the sun. Mr. Croll had recently assigned reasons leading to the conclusion that the climate, at all events, in the circumpolar and temperate zones of the earth, would depend on whether the winter of a given region occurred when the earth at its period of greatest eccentricity was in aphelion or perihelion. If the former, the annual average of temperature would be lower; if the latter, higher than when the eccentricity of the earth's orbit was less. If Mr. Croll's theory on the subject were correct, we should be able to approximate to a test of the time which had elapsed between the different geological epochs. That gentleman's computation on the point would certainly make it not less than 100,000 years since the last glacial epoch, a time not very long in geological chronology. When we compared with the old theories of the earth, by which the apparent changes in its surface were accounted for by convulsions and cataclysms, the modern view inaugurated by Lyell, now, if not wholly, at all events to a great extent, adopted, it seemed strange that the referring past changes to similar causes to those which were now in operation should have remained uninvestigated until the prescut century. But it was easier to invent a *Deus ex machinâ*, than to trace out the influence of slow continuous change. In geology a deluge or volcano was supplied; in palæontology a new race was created whenever theory required it; how such new races began the theorist did not stop to inquire. A curious speculator might say to a palæontologist of even recent date in the words of Lucretius:—

"Nam neque de cælo cecidisse animalia possunt
Nec terrestria de salsis exisse lacunis.
. . . .
"E nihilo si crescere possent,
(Tum) ficrent juvenes subito ex infantibus parvis
E terrâque exorta repente arbusta salirent;
Quorum nihil fieri manifestum est, omnia quando
Paulatim crescunt, ut par est, semine certo,
Crescentesque genus servant."

—which might be thus freely paraphrased, "You have abandoned the belief in one primæval creation at one point of time, you cannot assert that an elephant existed when the first saurians roamed over earth and water. Without, then, in any way limiting Almighty power, if an elephant were created without progenitors, the first elephant must, in some way or other, have physically arrived on this earth. Whence did he come? did he fall from the sky (*i.e.* from the interplanetary space)? did he rise moulded out of a mass of amorphous earth or rock? did he appear out of the cleft of a tree? If he had no antecedent progenitors, some such beginning must be assigned to him." He knew of no scientific writer who since the discoveries of geology had become familiar, ventured to present in intelligible terms any definite notion of how such an event could have occurred; those who did not adopt some view of continuity were content to say God willed it; but would it not be more reverent and more philosophical to inquire by observation and experiment, and to reason from induction and analogy, as to the probabilities of such frequent miraculous interventions? He knew he was touching on delicate ground, and that a long time might elapse before that calm inquiry after truth, which it was the object of associations like that to promote, could be fully attained; but he trusted that the members of the British Association were sufficiently free from prejudice, whatever their opinions might be, to admit an inquiry into the general question whether what we termed species were and had been rigidly limited, and had at numerous periods been created complete and unchangeable, or whether, in some mode or other, they have not gradually and indefinitely varied, and whether the changes due to the influence of surrounding circumstances, to efforts to accommodate themselves to surrounding changes, to what was called natural selection, or to the necessity of yielding to superior force in the struggle for existence, as maintained by our illustrious countrymam Darwin, had not so modified organisms as to enable them to exist under changed conditions. The question, whether among the smallest and apparently the most elementary forms of organic life the phenomenon of spontaneous generation obtained had recently formed the subject of careful experiment and animated discussion in France, and the general opinion which was arrived at was that, when such precautious were taken as to exclude from the substance submitted to experiment all possibility of germs from the atmosphere being introduced, no formation of organisms took place. The balance of experiment might, therefore, be fairly said to be against spontaneous generation. The progressive and more highly developed forms were, at all events, so far as the most enlarged experience went to show, generated by reproduction. Now, to suppose a zoophyte the progenitor of a mammal would, at first sight appear to be an extravagant hypothesis, but the more the gaps between species were filled up by the discovery of intermediate varieties, the stronger became the argument for transmutation, and the weaker that for successive creations became. The former view, then, became more and more consistent with experience, the latter more discordant from it. Certain it was that the more we observe the more we increased the subdivision of species, and, consequently, the number of those supposed creations to which he referred; so that the new creations became innumerable, and yet of those we had no well authenticated instance, and in no other observed operation of nature had we seen such a want of continuity as would be evidenced by those frequent *per saltum*

deviations from uniformity, each of which was a miracle. The doctrine of Cuvier—every day more and more borne out by observation—that each organ bore a definite relation to the whole of the individual, seemed to support the view of indefinite variation. If an animal sought its food or safety by climbing trees, its claws would become prehensile, the muscles which acted on those claws must become more developed, and each portion of the frame would mould itself to its wants. Another series of facts which presented an argument in favour of gradual succession, were the phases of resemblance to inferior orders which the embryo passed through in its development, and the relations shown in what was termed the metamorphosis of plants; facts difficult to be accounted for on the theory of frequent separate creations, but almost inevitable on that of gradual succession. There was, however, a difficulty in the way of tracing a given organism to its parent form, which from our conventional mode of following up genealogies, was never regarded in its proper light. Where were we to look for the remote ancestor of a given form? Each one among them, supposing none of their progenitors to have intermarried with relatives, would have, at about the period of the Norman Conquest, upwards of a hundred million direct ancestors of that generation, and if the intermediate ancestors were added, double that number. Let anyone assume that one of his ancestors at the time of the Conquest was a Moor, another a Celt, and a third a Laplander, and that those three were preserved while all the others were lost, he would never recognize either of them as his ancestor; he would only have the one-hundredth-millionth of the blood of each of them, and as far as they were concerned, there would be no perceptible sign of identity of race. The recent discoveries in palæontology showed that man existed on this planet at an epoch far anterior to that commonly assigned to him. The instruments connected with human remains, and indisputably the work of human hands, proved that to those remote periods the term civilization could hardly be applied. A little step-by-step reasoning would convince the unprejudiced that what we called civilization must have been a gradual process. If even now habit, and prejudice resulting therefrom, vested interests, &c., retarded for some time the general application of a new invention, what must have been the degree of retardation among the comparatively uneducated beings which then existed? He had, of course, been able to indicate only a few of the broad arguments on this most interesting subject: for detailed results the works of Darwin, Hooker, Huxley, Carpenter, Lyell, and others must be examined. If he appeared to lean to the view that the successive changes in organic beings did not take place by sudden leaps, it was, he believed, from no want of impartial feeling. Perhaps the most convincing argument in favour of continuity which could be presented to a doubting mind would be the difficulty it would feel in representing to itself any *per saltum* act of nature. Who would not be astonished at beholding an oak tree spring up in a day, and not from seed or shoot? If we were satisfied that continuity was a law of nature, the true expression of the Almighty Power, then, though we might humbly confess our inability to explain why matter was impressed with this gradual tendency to structural formation, we should cease to look for special interventions of creative power in changes which were difficult to understand, because, being removed from us in time, their concomitants were lost; we should endeavour from the relics to evoke their history, and when we found a gap not to try to bridge it over with a miracle. Philosophy ought to have no likes or dislikes, truth was her only aim; but if a glow of admiration were permitted to a physical inquirer, to his mind a far more exquisite sense of the beautiful was conveyed by the orderly developement, by the necessary inter-relation and inter-action of each element of the cosmos, and by the conviction that a bullet falling to the ground changes the dynamical conditions of the universe, than could be conveyed by mysteries, by convulsions, or by cataclysms. But the doctrine of continuity was not solely applicable to physical inquiries. The same modes of thought which led us to see continuity in the field of the microscope as in the universe, in infinity dowards as in infinity upwards, would lead us to see it in the history of our own race. By patient investigation how much had we already learnt, which the most civilised of ancient human races ignored! But how much more might we not expect to know? They assembled, ephemera as they were, had learnt by transmitted labour to weigh, as in a balance, other worlds larger and heavier than their own; to know the length of their days and years; to measure their enormous distance from the earth, and from each other; to detect, and accurately ascertain the influence they had on the movements of our world, and on each other; and to discover the substance of which they were composed; might they not fairly hope that similar methods of research to those which had taught them so much, might give our race further information, until problems relating not only to remote worlds, but possibly to organic and sentient beings which may inhabit them, problems which it might now seem wildly visionary to enunciate, might be solved by progressive improvements in the modes of applying observation and experiment, induction and deduction?

It is impossible for us to give a full report of the papers read before the several sections. We will introduce two or three now and make such a selection for our ensuing number as may interest our readers.

Section G.—Mechanical Science.

In this section the president (Mr. Hawksley, C.E.), pointed out that the inquiries of the section were limited for the most part, if not altogether, to those branches of statics and dynamics which were or might be employed for the realisation of so-called "practical ends," and then continued—"Whatever may have been the advancement which civilised people have made in the arts of peace, it is only too evident that those peoples have even outstripped themselves in advancing the arts of destruction. We have seen in the great internal contention of our American brethren, and still later in the struggle in which several of the most important States of Europe have engaged, that war is no longer carried on by means of mere animal courage and brutal force. On the contrary, we perceive, much to our amazement, I believe, that the highest branches of mechanical science and the most refined processes and operations of the mechanical arts are resorted to by the modern warrior for the purposes of offence and defence, and we are taught by the logic of facts that the modern soldier must cease to remain a passive machine, but on the contrary, must henceforth be trained as a skilled labourer, if, indeed, not even as a skilled artisan. At the present moment the internal and external defences of this country are in a most unsatisfactory condition. Many endeavours have been made, and much money, reckoned by millions, has been expended, I will not say wastefully or unworthily, but certainly for the most part uselessly, in endeavours to secure our coasts against the attacks of a foreign enemy. Forts have been erected where an adversary would never seek to land. Ships of an enormous size, and carrying enormous armaments, have been constructed which can neither sail on shallow waters nor safely encounter a hurricane in deeper ones, which, with vast mechanical power on board, can yet not carry a sufficient quantity of coal to enable them to find their way to and act as protectors of our colonies, and which, for the same reason, are wholly unable to convey our merchantmen to those distant climes, without a safe communication with which the trade and commerce of England must be annihilated. Arsenals have been enlarged, if not constructed in situations in which they can only be secured from an enemy's fire by fortifications which it will require an additional army to man. Guns, each one larger or more elaborate than the last, have been invented, and constructed, and tried, and floating castles each one heavier and uglier, and more unmanageable, and more useless (except for special applications) than the former one, have been built and cast upon the waters to resist them, and yet it is lamentable to have occasion to say it, nearly all the many naval and military officers with whom I have come in contact freely acknowledge that this great country is not in a position to defend either herself or her colonies against a combined attack from more than one of those foreign friends we have heretofore recognised under a different appellation. There were present gentlemen who would enlighten the Association upon the mechanical appliances best adapted for the improvement of our defences, and who would also not neglect the consideration of so much more of our science as contributed to the material wealth and prosperity of our country, and to the social comfort and intellectual improvement of its inhabitants and of the whole world. Mr. Hawksley then directed attention to the many points of interest peculiar to Nottingham and its neighbourhood. You will find here (he said) in the lace machine combinations and arrangements of mechanism of the most complicated yet of the most exact kind, all tending to the cheap and rapid fabrication of an article of commerce which has made its way over the entire world, and without the possession of which no home, and I had almost said no lady's dress, can be considered complete. The present state and extent of this really wonderful manufacture is an instance, and even a remarkable one, of the effect of that law of continuity which last evening formed the staple of our president's address. It has only been by little and little, but by close and continuous progression, that the lace mechanism of Nottingham has become developed into that condition of almost perfection to which it has now attained. The excursionists will find in the geology of this district much to invite their attention. Within a very few miles many of the most interesting formations of the earth's crust come to the surface, from the syenite at the base of the system to the more recent deposits of lias and oolite. Coal and ironstone are very abundant, and although it is to be regretted that the town of Nottingham has not yet availed itself of the vast amount of mineral wealth within its reach, yet in the large undertakings at Butterley, Riddings, and other places, as well as the great extent to which the Midland Coalfield is being wrought for the supply of distant countries, you will see evidences of the growth of a local industry which, as I believe, is yet in its infancy.

The following was the list of business in this section:—Mr. W. J. Macquorn Rankine, LL.D., F.R.S., "Report of the committee 'On the Resistance of Water to Floating and Immersed Bodies,'" and "Remarks on the Experiments of the foregoing Committee;" Mr. R. Mushet, "On the Treatment of Melted Cast Iron, and its Conversion into Iron and Steel by the Pneumatic Process;" Mr. John Daglis, "On the Counterbalancing of Winding Engines for Coal Mines;" Mr. W. E. Carret, "On an Hydraulic Coal-cutting Machine;" and Mr. Frederick Ingle, "On Recent Improvements in the Application of Concrete to Fireproof Construction."

Professor Macquorn Rankine laid before the Section a copy of a treatise on "Shipbuilding, Theoretical and Practical," presented to the British Asso-

ciation by the publisher, Mr. William Mackenzie; to whom the thanks of the meeting were voted.

ON AN HYDRAULIC COAL CUTTING MACHINE.

By Mr. W. E. Carrett.

In the general detail of mining operations, the cutting away of the under portion of a valuable seam or bed of mineral to facilitate its subsequent removal, is at all times one of the most laborious and difficult operations, and is often effected by the miner under the greatest physical disadvantages, more especially when the seam of coal is very thin, and is cut on the "end" to improve its saleable qualities. This "holeing," or "bareing," or "kirving," or "undercutting," is usually performed by about 40 blows per minute from a pick, handled with such experience as to cut 3ft. to 4ft. under, at the rate of 1yd. to 1½yds. lineal per hour, and destroying much of the coal to make room for the operator, and enable him to work partly into the hole, to produce the requisite depth for a fall.

The speed and effort with which this picking tool is moved, combined with its weight, represent the power of one man, applied in the shape of "percussive force," and this, under advantageous circumstances, is equal to about one-sixth of a horse-power. The miner could not, with his limited power, force his pick, or any other shaped tool into the coal as if he were cutting cheese; he is like the mechanic, who has to chip all his iron work with hammer and chisel for want of a planing or slotting machine, and must reduce it by little as best he can, "in lieu" of suitable mechanical expedients to concentrate and apply power in a continuous, undeviating, and determined line. Yet the introduction of planing or slotting machines has not injured the mechanic, nor the morticing machine the joiner; there is ample work which the machine cannot do; and there are innumerable mines where no machinery can compete with the skilled miner. To apply the power of horses in lieu of manu-motive power, even though one horse is as powerful as six men, is practically very difficult. The power of both is dependent on the produce of cultivated lands; and the fewer horses required the cheaper the necessaries for human sustenance.

There is yet a far more effective substitute for the power of both man and horse, which has been inviting our use for centuries, in the form of what Geo. Stephenson conceived to be "bottled up sunshine." A coal-fed steam engine, of one horse power, is twelve times cheaper than one animal horse power, and our obedient servant for 24 hours daily, consuming the produce of uncultivated lands on which the sun shone ages ago.

Now it is desirable that in many favourable circumstances this "undercutting" operation of the miner should be accomplished indirectly by this steam power, and one of the practical methods of accomplishing this object is the subject of present consideration.

If one collier had the power of say eighteen men, and when necessary could make himself 2ft. high, and hold himself down upon the floor of the mine by pressing his head against the roof, and hold firm in his hands a kind of cheese scoop in lieu of a pick, and could force it steadily into the coal at the necessary height from the floor, and to the required depth, he would then be exactly what is in many cases wanted; he would be a travelling morticing machine, and do more in one minute than 700 blows from a hand-wrought pick can do, and would, in fairness, demand a very stiff wage, which he would undoubtedly obtain.

This is what the iron man or hydraulic coal cutter accomplishes. "He" is, if necessary, 2ft. high, has four legs, of adjustable length; his head is also adjustable to touch the roof, and he weighs one ton. He is fed by a 2inch flexible pipe with sober drink, at 300lbs. pressure, and at the rate of thirty gallons per minute.

This water pressure acts vertically on a 5in. piston pressing against the roof, and horizontally on one about the same size, reciprocating 18in. and fifteen to twenty times in a minute. There is a pressure of 5,000lbs. against the roof, and the same pressure acting horizontally, forcing three "cheese scoops" into the coal. These cutting tools are 3in. wide, and penetrate 4ft., with a power equal to three horses or eighteen men; and this is effected by a consumption of 50lbs. of coal per hour to feed the boiler of the engine, which makes the water pressure, and pumps the same over and over again. Thus the automaton iron man is dead fast when forcing the cutters into the coal, and only requires to lower 1in. at the return or back stroke, and advance, which he does also self-acting, at its termination, half-an-inch to one inch, and then again elevates his head and is ready for the next cutting stroke; his sober veins being filled by incompressible if not exhilarating "water," and retained therein by a keep valve, for the necessary time, enabling him at that moment to defy the roof to crush him.

This self-acting hydraulic coal-cutting machine, or iron man, which has now been two years at work, does not dispense with the miner's labour, but performs for him the undercutting, which is a most laborious operation, either in the end or face of coal, and in a more efficient and economic manner than he can do it himself. The coal so operated on by the machine does not fall forward when beoming detached from the roof, but settles on the lower bed, thereby avoiding serious accidents. The saving in coal alone more than pays for the outlay; and it is practicable to cut with the most perfect ease into the floor of mine, thus preventing all waste of coal whatever. (See fig. 3.)

The size of the coal is improved, the amount of slack is considerably reduced, and a single seam will yield more by one thousand tons of coal per acre, than when worked by hand labour in the usual manner.

The machine undercuts holes or kirves, with a man and boy as attendants, and completes the work with once going over, at the rate of fifteen yards per hour, and at an angle and height from floor or rails, being suitable for either dip or rise workings, and is capable of cutting the thinnest seams. The pressure of water which actuates this apparatus can be obtained either from the stand pipes in the pit, or from pumps specially made for the purpose. The quantity necessary is only what is sufficient to fill the circuit of the pipes, using it over again when desirable, as in the Bramah press. Any idea of a large volume of water being necessary may therefore at once be dispelled. There is also no leakage whatever.

Each machine uses thirty gallons per minute, at about 300lbs. pressure, according to the hardness of the coal or mineral to be operated upon. In cutting the shale of the Cleveland ironstone band, a somewhat greater pressure is found to be necessary.

There is no limit to the pressure of water that may be used, nor the distance it may be forced without loss of power, beyond that due to its friction along the pipes. The same water pressure is also applicable to work pumps and rotative engines for hauling, &c., and other requirements in the mine, at a distance from the engine power.

In cases where there is a fall of water, say of 100lbs. pressure, it can be "intensified" by a self-acting machine to 400lb. pressure, to work the coal cutter, but sacrificing three-fourths of its bulk, which is thereby set free.

The water is supplied in a continuous stream; it is, in fact, the medium through which the mechanical power is applied direct from the first coal-fed motor, (a steam engine and pumps) in lieu of the usually developed power derived from vital energy, and applied to the handle of the pick, effecting the desired object by a series of percussive blows or impacts. The power of six men is equal to one horse, and is six times more costly; and the power of one horse steam motor, or engine, is eighty times cheaper than six men. The machine is about three horse-power, and weighs one ton, and will work either right or left. (See dotted lines on sectional plan, fig. 2.)

It is self-acting in all movements, and will ascend the steepest gradients; being simple in all its parts, it is not liable to get out of order, and is easily managed by an ordinary miner, and transported from place to place, on the ordinary rails, about the mine.

Although the length of stroke of each cutting tool is 18in., the practical cutting length is 16in., and consequently, the three cutters jointly give a total effective depth of 4ft. at each stroke of the machine, finishing the work as it goes along. The mechanism employed consists of an hydraulic reciprocating engine, adjustable to any height and angle, having a self-acting valve motion. The cylinder is 4½in. diameter, and lined with brass, and the piston made tight with ordinary hydraulic leathers, easily renewable. Within the piston rod is attached the cutter bar of steel, carrying the tools or cutters. These can be varied in number to suit the depth to be holed at one operation. The cutting tools are of double sheer steel, easily made, and very strong, and can be removed and replaced in a few moments; they are readily sharpened on an ordinary grindstone. The cutter bar is also removable, when transporting the machine from place to place, for which purpose the main cylinder is, for the time being, placed longitudinal with the rails. (See dotted lines in fig. 1.)

The machine in operation fixes itself dead fast upon the rails during the cutting stroke, and releases itself at the back or return stroke, and traverses forwards the requisite amount for the next cut, without any manual labour. Should the tools be prevented making the full stroke at one cut, they will continue to make more strokes at the same place, until the maximum depth is attained, when, "only" the machine will traverse itself forward the required amount for the next cut. Thus, at one operation, a uniform straight depth is attained, parallel with the rails, inducing an even fracture when the coals are brought down, and thereby a straight line for the new coal face. There is no percussive action, either against the roof or into the coal, but simply a concentrated pressure, producing a steady reciprocating motion, at fifteen strokes per minute. There is, consequently, no dust or noise, and little wear and tear.

For the same reason, when cutting pyrites, the tools throw out no sparks, and the workman can hear any movement in the coal or roof.

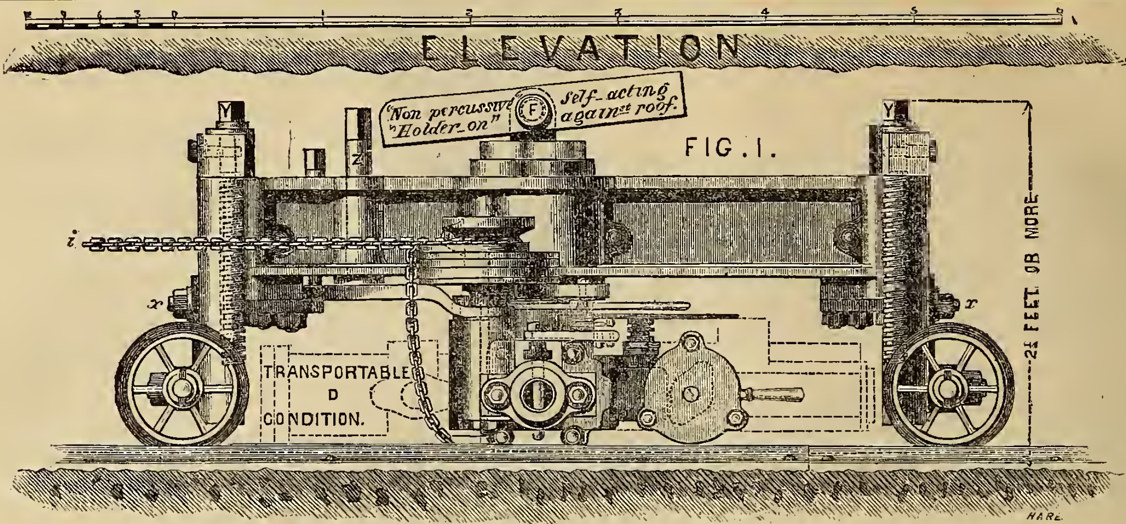
The required height from the line of rails in the "holeing," "kirving," or "bareing," varies in different mines, it follows that the hydraulic cutting cylinder, and its direct action cutting tools, have sometimes to be arranged above the carriage, and sometimes beneath the main carriage, or close down upon the rails, as is illustrated in figs. 1 and 2. Fig. 1 is the main carriage, with four wheels far enough apart to allow the machine to be placed longitudinally when being transported from place to place. The screws YY are for raising and lowering the carriage and its cylinder and cutting tools. The pinion Z and the segmental rack H regulate the desired angle of the tools cutting into the coal face, and the two nuts at each end of carriage, *x x*, regulate the angle required, when necessary that it shall not be in the same plane as the rails.

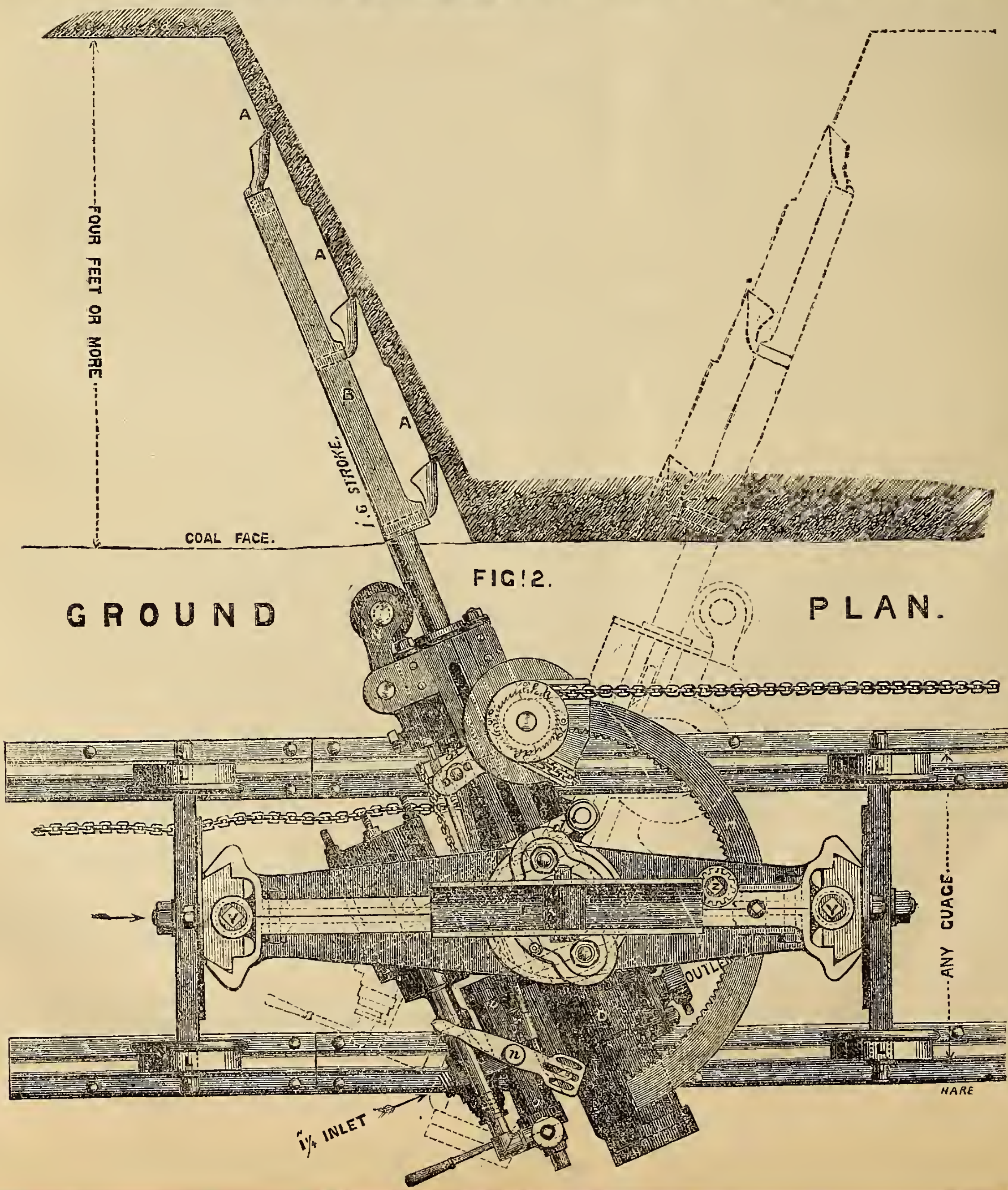
AAA are the cutting tools, B the cutter bar, N a guide roller for the same D is the main cylinder, with its self-acting hydraulic valve motion, which passes a portion of its water alternately above and below the piston of the holder-on, which thus rises and falls without percussion, and follows the uneven line of the roof of the mine, so that the required stability is given to the machine for the time being, an instant before the cutters enter the coal.

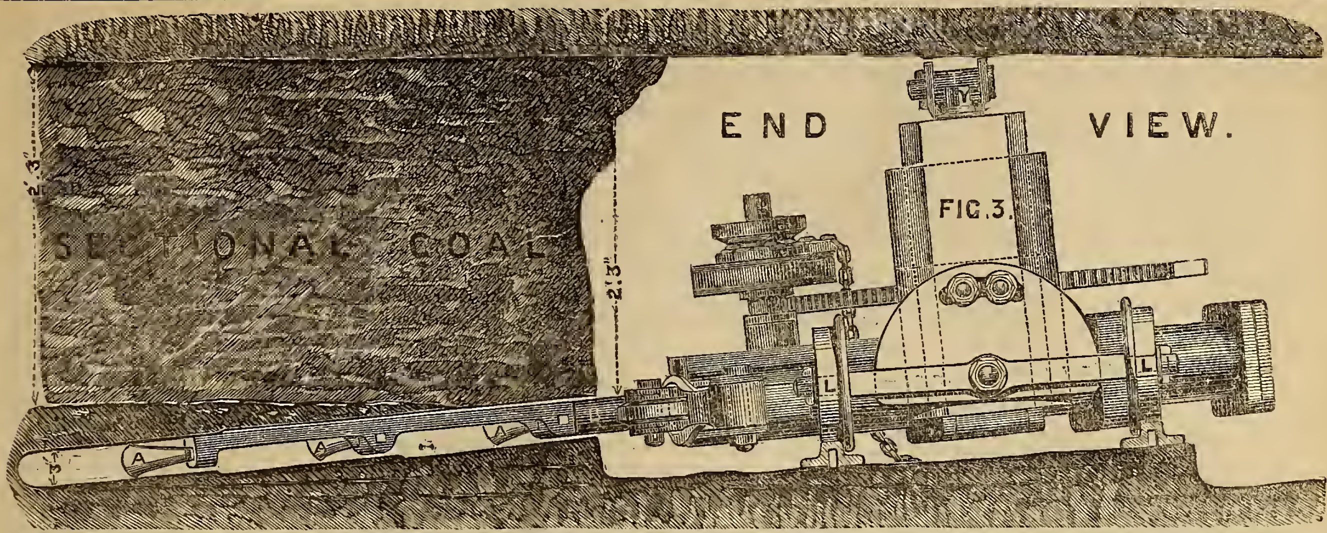
The "holder-on piece" can be any length necessary to bridge over gaps in the roof; it is loose on the pin F and droops at its leading end to enable it to ride over the varying projections in roof.

The traverse motion is actuated by the pin *b*. which connects the cutter bar with piston rod, and at the termination of each end of its stroke actuates the lever *d* in both directions, which operates on the pall *e*, which causes the chain-pulley to revolve on the chain *i*, made fast ahead by an anchor-prop between floor and roof.

The water is conducted any distance along wrought-iron gas pipes, and is used over and over again as in the Bramah press. The elevational view fig. 3 shows the machine adapted to the guage of any mine when in "transportable" condition with the cutter bar removed. The tools are easily made and replaced, to sharpen on an ordinary grind-stone.


ELEVATION
"Non percussive" "Holder-on"
F
Self-acting against roof.
FIG. 1.
Y
Y
Z
i
x
x
TRANSPORTABLE
D
CONDITION.
2½ FEET OR MORE
HARE.


A
A
B
A
FOUR FEET OR MORE
1.6 STROKE.
COAL FACE.
FIG. 2.
GROUND
PLAN.
ANY GUAGE
OUTLET
1¼ INLET
HARE



SECTION G.—THEORY OF THE INFLUENCE OF FRICTION UPON THE MECHANICAL EFFICIENCY OF STEAM.

By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S., Lond. and Edin.

Abstract.

The results arrived at by the author of this paper, are based on the following principle. Let W be the indicated work of a given quantity of steam, without loss by friction, and H the mechanical equivalent of the expenditure of heat required in order to do that work; so that $W \div H$ is the efficiency of the steam without friction. Let F be the quantity of work lost through friction in the cylinder; and let the heat produced by that friction be wholly taken up by the steam. Then the work done is diminished to $W-F$; and the heat expended to $H-F$; so that the efficiency becomes $\frac{W-F}{H-F}$. The special way in which the friction takes effect in ordinary steam-engines, is by diminishing the expenditure of heat required for the prevention of liquefaction in the cylinder.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

THE COLLISION BETWEEN H.M.S. "AMAZON" AND THE S.S. "OSPREY."—REFLECTIONS UPON THE CONSTRUCTION AND ADMINISTRATION OF OUR NAVY.

To the Editor of THE ARTIZAN.

SIR,—A collision in the Channel is by no means unfrequent. Nor need we be surprised at such an occurrence in a great marine highway, where hundreds of ships are passing hourly. They often jostle each other, and "move on" to their destinations. The authorities have established "light" signals for ships, to warn each other of their approach in the darkness of night, but neglect often dims or abrogates their utility, and we have collisions. The admiralty have enforced these regulations by their orders to the navy, and the legal tribunals amerce those in costs who dare to neglect the regulations. At sea, on the great ocean, we sail, maybe, for months without so much as "sighting" a ship. Hence the necessity for each officer doing his duty, in an increased degree of caution and of vigilance, when in the crowded Channel, to avoid collision. Still such things do occur. But when they occur, it in general happens, that some fog, or other "dirty weather," has been available for an excuse of any neglect of duty. In the collision between the *Amazon* and the *Osprey*, prescribed lights were ablaze on board of both the unfortunate vessels at the time, and officers, and crews of both alike, are deprived of the common excuse of weather. Everything around them was calm and serene, with a light breeze. They could have avoided collision, if so minded. I am by no means an admirer of the notion that a man-of-war should expect everything to "sheer off" her chosen track, or suffer. The captain gives the course to be steered in his absence from the deck, to "the lieutenant of the watch," and this "course" is imperative, and must be obeyed; but, however imperative, it is subject to circumstances, such as that before us, involving the life, or death, of unoffending helplessness. The officer of the watch has the power to avoid this sacrifice, and his humanity remains unquestioned. But we find he did exercise it either too late, or in a questionable manner. The *Amazon* might not have been seen in time, on board the *Osprey*, to avoid collision. The smaller ships instinctively give the men-of-war "a wide berth." The latter have the *prestige* of keeping a vigilant look-out on each bow, and, being *very* strong, of course the weaker must suffer in a collision. Here was a collision. Had the look-out, or the officer of the watch neglected his duty? but which was the weaker of the two vessels when both suffered, and went down to the bottom almost together? is a question that remains to be decided. For, the stronger is not stronger than her weakest part, and as the protruding bow alone was engaged in this catastrophe, the fact may betray this to be the weakest part of the *Amazon*, seeing the man-of-war shared the fate of the passenger steamer. The *Amazon*, a sloop-of-war, was under weigh going down Channel, on the night, or rather early morning, of Tuesday, the 10th of July, bound for Halifax, to join the North American squadron. The *Osprey* was a Liverpool screw steamer. of 450 tons, on her way from that port to Antwerp, and therefore was coming up-channel. Ten lives were lost in a collision of these two, and both ships now lie at the bottom of the water some 18 miles off Dartmouth. Such are some of the unadorned, the lamentable facts.

The *Amazon* was not only a perfectly new ship, but also was the first of a novel construction, with us, and thus invites attention. She was designed by the Chief Constructor of the Navy, to realise a greater speed with the *Amazon*, than with others of her class, or armament, such as the *Rinaldo*, *Roebuck*, &c. She was also to carry more powerful guns. The armament of the *Amazon* consisted of four guns, two of them being $6\frac{1}{2}$ tons weight, and firing 100lbs. round shot, with 25lbs. charges of powder. These formidable guns were not carried at the sides, but ranged along the middle line of the deck, and near the main hatchway. By a new arrangement of the gun-slides, &c., it was expected to load and fire these guns quickly, and they could be brought to bear, and fought on either side of the ship. But these latter points are common to ships of her class. In addition to these two heavy guns, the *Amazon* carried a 64 pounder rifled gun at the bow, and another on the quarter deck, each capable, like the central guns, of being fought on either side. In her completeness, the *Amazon* could give chase to an enemy with a prospect of success, her speed being about $12\frac{1}{2}$ knots, and choose her position for attack with advantage, whilst her armament was far more formidable than any sloop-of-war of like size had hitherto borne into action. She was of 4,080 tons. The speed of the old, or senior vessels of her class, was 10·25 and 11·1 knots respectively.

I notice the engines simply for the novelties introduced, than from any question arising out of their efficiency. They were manufactured at the well-known establishment of Messrs. Ravenhill, Salkeld & Co. These engines have been designated by some "the economical class." This class of engine is in use on board the *Enterprise*, the *Pallas*, the *Bellerophon*, and other armour-plated ships and in wooden frigates, but not before in any wooden ships of the Royal Navy. The *Amazon* had also another form of screw-propeller not generally used, but which has obtained the preference in the French Navy. The principal novelty connected with these engines, occurs in the small space occupied by the boilers, and much importance has been attached to the use of a system of superheating the steam, affording a great expansion of steam in the cylinders. She was supplied also with surface condensers, which had hitherto worked well, and on which so much must depend for the success of smaller boilers, the economic relation of fuel expended to the power, and speed of the ship. The results in this case were highly satisfactory. The speed of the *Amazon*

proved to be 12·4 or very nearly $12\frac{1}{2}$ knots; 13 were expected. The difference has been attributed to an increase of weight in her armament, and complement, and to an increased submersion of her after body; the latter with the intention of screening her rudder-head, deviations which expose more bungling than science. She was the fastest of our unarmoured frigates. The bow was prolonged below, to give her a finer entrance into, or through the water and thus increase her speed. It is denied that she was intended to act as a ram; it is certain she was not fitted to act that part. This peculiar form of the bow must have invited much attention to the disposition of the materials composing that very exposed, and very fine part of her hull. It was however "borne to grief," and must, in the nature of things so constructed, sooner or later be in the way of mischief. If the materials were not properly disposed, she was likely, very likely, to go down at her anchor, when her cable, intended for succour could have been the cause of her destruction, by simple contact with her "fore foot," aye even in harbour. I have no intention of quarrelling with the idea of abandoning the raking stem, of a steam vessel, nor with the prolongation of the bow. The alteration can increase the speed of the vessel, and ease her pitching motion, by increasing the displacement, and increasing the power of floatation, where it is wanted in such a ship. These advantages are complete, when they are obtained with such an arrangement of material as can preserve the safety of the ship, when encountering common liabilities. In a word, this protrusion might have been an independent structure, a kind of false bow. The elements of strength must be more or less sacrificed to fineness, when that is the object aimed at, whilst the conditions for safety remained to be consulted independently, seeing that these imperative conditions may not be disregarded with impunity.

There was no formidable weight of metal on this stem, but merely a light, brass "fore foot," nicely tapered and fitted, to complete the "clean entrance" intended. There was less necessity for that amount of internal bracings, and fastenings, that may be desirable for an armoured ram, whilst the demand for sufficient safety was imperative. Bracings and fastenings on an insufficient foundation however, are elements of weakness. The *Amazon* was strengthened in the after part, to withstand the peculiar twisting strain of the screw. Her bow, we are told, became twisted and wrenched round by the collision with this passenger steamer, causing immense openings, through which the water rushed in large volumes. Her strength was tested on the bow, and she sank under the treatment. The officers and crew left the *Amazon* about half-past three. The *Osprey* had been made too much of a wreek, to remain any time in sight, and she took ten of those on board, to the bottom.

It becomes us, therefore, to reflect upon the construction of our navy, which is, in some instances, exposed to annihilation by the commonest accident.

The First Lord of the Admiralty may be an able, a sound politician, and of admirable administrative ability. Here we must of necessity take much for granted. He may preside at a discussion on the merits of a proposition, and decide in favour of what may appear to him to be the best side of the argument. Will he take so much trouble? The surveyors' argument must be confined to a "report," for he has no "seat" at the Board of Admiralty; and what is plain to his experience, may be the turning point in the discussion of the Admirals. These gentlemen in their innocence may be compelled to allow caprice—in the science of construction—to do duty for experience; and they decide with becoming dignity. As well might his Lordships' coachman, be also his carriage builder. If all goes well, their Lordships' credit is immense; if adversity overtakes any scheme, then we hear of the surveyor or of the navy, or the constructor, as they may please to designate the individual. It was very awkward when this functionary was one of "the cloth;" Captains being the very material out of whom Admirals are made. A civilian in this position makes things more pleasant.

Ever since Sir James Graham sowed confusion broadcast and muddled the Navy Board, under the plea of economy, we may have seen the surveyorship of the navy, bandied about from post to pillar, and no one satisfied. But I will deny myself the narration of consequent extravagancies, in the absence of necessity, and address myself, in preference, to the task of a brief outline of how such expensive extravagancies may be avoided in the future.

There should be a staff, call it a "board of construction," under a chief who should be in direct communication with the first lord, for, a talented, educated gentleman cannot be inferior to an admiral, under such circumstances. This board should correctly ascertain, and tabulate every structural element and furniture of every class of ship in the navy. It should frame an outline of report of the behaviour of the ship, to be filled up daily by every captain of a ship in commission, and record each report on receipt. Thus would theory be confirmed, or errors be discovered and corrected by experience of the behaviour of each ship, under every change of circumstance. Thus would grow up an accumulated mass of valuable experience, to become the guide to that department in future. Details suggest themselves. I could point at expensive experiments in the navy repeated in thirty years, because no record of the past could be found if ever made, It was somewhat after the fashion now proposed, that the Spaniards attained the ability to build some of the finest and swiftest men-of-war that ever floated. Naval architects never ceased admiring the *San Josè* which, a few years since, bore the port admiral's flag at Plymouth; and who has forgotten the reputation of the *Caledonia*, built on the Spanish model of, I believe, the *Santisima Trinidad.*

The whims or caprices of admirals should never be permitted to interfere with recognised principles of construction. The board of construction should be held responsible for meeting all the requirements of a ship after her class, or distinguishing feature, may have been decided on by the superior board of admiralty.

There is another branch of superior duties in the construction of a navy, duties which are best performed by superior experience in the disposal of material: if this does not receive suitable attention and direction, the vessel might founder ere she gets eighteen miles from the coast. As, in the former case, the most able mathematician might be selected from the members to be chief of the board of construction, and vacancies among his assistants might be desirably filled from the talent of our dock yards. So also our dock yards can supply, in the ablest among the master shipwrights, a perfectly suitable surveyor of the navy, and this position should be worthy of their professional emulation. From that important class of experienced gentlemen, there would be no inclination to appeal. If the candidate had seen foreign service, it must aid the decision in his favour. Such is the outline. I apprehend there is but little novelty in it, yet some practicability may be found to recommend it to attention. Thus, each branch, and its responsibilities, might become complete in itself, befitting its requirements, yet all linked together, forming a legitimate whole, controled by a superior, a politically responsible head. We do not stop to recognise the possibility of antagonistic elements, when they can so easily be dispensed with.

A Naval Architect and Engineer.

BENCH-MARKS.

To the Editor of The Artizan.

Sir,—I see in the engineering newspapers that the French Government are having a series of levels taken throughout France, for the purpose of establishing bench-marks all over the country to a uniform datum; that the operations were commenced in 1857 under the superintendence of M. Bourdaloue, C.E., and that they will not be terminated for five or six years to come; that this gigantic operation is very costly, but, when once completed, "it will enable every engineer or contractor who may wish to attach a series of levels in any part of France with those of the remotest districts to do this by aid of a branch mark on the spot, or near at hand, for the maximum space between the levels is to be only three-quarters of a mile;" and that "the accuracy of these levels is such that they are true to 3 centimetres, or 1·2in. for the whole length throughout France."

Now, I gather from Mr. Peacock's interesting papers, which you are now publishing in The Artizan, "On Vast Sinkings of Land on the Northerly and Westerly Coasts of France, within the Historical Period," that in some localities, within the memory of man, the ground has materially altered its level; if so, how long will these bench-marks be true "to 3 centimètres for the whole length throughout France?" and is it worth the expense having these permanent bench-marks, consisting of cones of cast iron set in masonry, erected at intervals not exceeding three-quarters of a mile all over the country?

Putting this question aside, I should like to know how far our ordnance bench-marks in England are to be relied upon. In the colliery and mining districts the ground is continually and perceptibly sinking—in Northumberland, Durham, Yorkshire, Cumberland, Derbyshire, Nottinghamshire, Lancashire, Cheshire, Staffordshire, Worcestersbire, Warwickshire, Leicestershire, Shropshire, Gloucestershire, and Somersetshire. The total coal produce of the United Kingdom for 1865 was 98,150,587 tons.

Then, again, there are occasional landslips, convulsions, and uprisings of the earth, and slight earthquakes.

In parts of Cheshire, in the neighbourhood of brine shafts, the country round has sunk many feet. At Winsford, within the memory of the inhabitants, the whole locality has sunk many feet, and the houses have to be tied and braced together with iron rods to prevent their falling.

London, August 21st, 1866. G. J. C. Dawson.

The Old Story.—A sad accident occurred on Tuesday, the 7th ult., near Sunderland, at the Earl of Durham's Lambton coal-drops. An engineman had allowed the boiler-plates of his locomotive to become over-heated for want of water, and on going to a tank for a supply, the water was scarcely put on when a tremendous explosion took place. The massive engine, 33 tons weight, was lifted off the rails, turned round, and thrown over, and four men who were on it so severely scalded and injured that the lives of two are despaired of. The engine was only about two years old, and was manufactured by Messrs. Hudswell and Clark, of Leeds.

The Results of Fire Insurance.—We learn, from the recently published report of the Royal Insurance Company, that, during the year 1865, life policies were granted amounting to £886,000, and the life and annuity funds were increased by £103,146 by the savings of the year. In the fire branch it appears that this Company is receiving larger accessions to its English business than any other company, as according to the Government returns of duty (supposing for the sake of comparison that it had all remained at the old rate of 3s. per cent.) no less than £17,700 more would have been paid by the Royal during 1865 than in the preceding year. The premiums last year on fire policies reached the sum of £414,000. With such sources of revenue as these the Royal, of course, finds no difficulty in standing the shock of the late adverse experience of all Insurance Offices in fire losses, and it is very satisfactory to learn that, after paying no less than £318,000 under this head in the twelve months ending December last, and declaring the usual dividend, the directors are still able to congratulate themselves on a reserve fund £24,000 larger than it was three years back.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Aug. 4.			Aug. 11.			Aug. 18.			Aug. 25.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	84	0	0	84	0	0	84	0	0	84	0	0
Tough cake, do.	81	0	0	81	0	0	81	0	0	81	0	0
Copper wire, per lb.	0	0	11½	0	0	11½	0	0	11½	0	0	11½
„ tubes, do.	0	1	0	0	1	0	0	1	0	0	1	0
Sheathing, per ton	86	0	0	86	0	0	86	0	0	86	0	0
Bottoms, do.	91	0	0	91	0	0	91	0	0	91	0	0
IRON.												
Bars, Welsh, in London, per ton	7	0	0	6	15	0	6	15	0	6	15	0
Nail rods, do.	8	0	0	7	10	0	7	10	0	7	10	0
„ Stafford in London, do.	8	10	0	8	10	0	8	10	0	8	10	0
Bars, do.	8	10	0	8	10	0	8	10	0	8	10	0
Hoops, do.	9	5	0	9	5	0	9	5	0	9	5	0
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	12	3	2	12	0	2	11	8	2	13	3
LEAD.												
English pig, ord. soft, per ton	20	0	0	20	5	0	19	15	0	19	15	0
„ sheet, do.	21	10	0	21	10	0	21	10	0	21	10	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	5	0	19	5	0	19	5	0	19	5	0
BRASS.												
Sheets, per lb.	0	0	9	0	0	9	0	0	9	0	0	9
Wire, do.	0	0	8¾	0	0	8¾	0	0	8¾	0	0	8¾
Tubes, do.	0	0	9¼	0	0	9¼	0	0	9¼	0	0	9¼
FOREIGN STEEL.												
Swedish, in kegs (rolled)	13	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	15	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qn., per box	1	10	0	1	8	6	1	8	6	1	8	6
IX „ „ „	1	16	0	1	14	6	1	14	0	1	14	6
IC „ 2nd qna., „	1	8	0	1	6	6	1	6	6	1	6	6
IC Coke, per box	1	4	0	1	3	0	1	3	0	1	3	0
IX „ „	1	10	0	1	9	0	1	9	0	1	9	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Steering Rules of Steamers.—In the Admiralty Court a case of collision between two steamers, *The Como* v. *Falcon*, has been decided, which affords another instance of the perplexity of the involved rules of steering, as regards steamers. *The Como* relied on rule 17, viz.:—"Every vessel overtaking any other vessel shall keep out of the way of the said last-named vessel." Dr. Lushington remarked—"It has been contended in this case that *The Falcon* was overtaking *The Como*, and if you (the Elder Brethren) should be of opinion that was the case, undoubtedly she did not comply with this rule." Mr. Brett has contended that the 14th rule applies—"If two ships under steam are crossing, so as to involve risk of collision, the ship which has the other on her own starboard side shall keep out of the way of the other." Both ships were inward bound for Liverpool, *The Falcon* steering S.E. by E. and *The Como* S.E. a little in front of *The Falcon's* port beam, a considerable distance off, when *The Como's* mast-head and green lights were seen; that shortly before the collision *The Como*, which had in the interval been gradually closing with *The Falcon*, suddenly altered her course to S.S.E. to pick up a pilot off Point Lynas, and stood across *The Falcon's* bow, and it became apparent that there was danger of a collision; that the engines of *The Falcon* were, therefore, asterned and stopped, and her helm put hard-a-port; but *The Como* came on, and with her starboard quarter struck *The Falcon's* port bow. "*The Como* was held solely to blame." Now it is evident that, to avoid misconception, Rule 14 has shortcomings which would be supplied by a few additional words as follows:—"If two ships under steam are crossing so as to involve risk of collision, the ship which has the other on her starboard side shall keep out of the way of the other by either stopping, slowing, or porting, so as to pass astern." The intention of this rule is to apply the same principle to steamers as laid down in Rule 12, for sailing ships:—"That if two sailing ships are crossing so as to involve risk of collision, the ship which has the wind on the port side shall keep out of the way of the ship with the wind on the starboard side. Ships close-hauled on port tack to give way, by porting to ships on starboard tack." But Rule 14 might be made still more consistent with the port-helm principle if altered thus:—"If two ships under steam are crossing so as to involve risk of collision, the ship which has the other on her port side shall keep her course, and the other shall either stop, slow, or port, and pass astern." It is much to be regretted that the responsibility of passing, steering, or sailing rules was transferred from the Elder Brethren of the Trinity House to the Board of Trade, for there has been, as Mr. Henley remarked, too much Board of Trade interference with shipping, and the sooner it ceases the better.—*Globe.*

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Preservation of Timber.—A very simple and ingenious mode of accomplishing this object has been suggested by M. Hossard, an orthopædic surgeon, of Antwerp. The timber is exposed to steam or any other means of raising the temperature sufficiently long enough to expel the juices. It is then quickly removed, and plunged into *a cold solution* of, say sulphate of iron, or any other salt which is inimical to fermentation, which is presently absorbed by the pores of the wood, which then sinks to the bottom of the bank. Of course a dye could be introduced whenever required, for ornament.

Cork Springs.—The cork used for these springs is of the commonest description harsh, hard, and full of fissures. It is cut into discs of about eighteen inches diameter, each pierced with a central hole. Previous, however, to cutting, it is soaked in a mixture of molasses and water, which give it some softness and renders it permanently moist. These cork discs are placed in a cylindrical cast iron box, a flat iron lid or disc is placed over them, and by hydraulic pressure they are forced down, so as to reduce the thickness to one-half. A bolt is then run through box, corks, and cover at the centre, and a nut being screwed on holds all in place, when the press is relieved and the box of compressed cork, disc, or cork spring is ready for use. One of these springs, placed in a testing machine under a weight of 20,000lbs., showed an elasticity suggestive of compressed air. A pressure which destroys india-rubber, causing it to split up and lose its elasticity, leaves the cork unimpaired, and it has been impossible with any pressure hitherto attainable, to injure the cork, even when areas of but one inch were acted upon. Mr. W. Sellers has had for some five years a forging machine in which a spring of the form and material above described was subjected to continual and violent shocks, and its performance had been most satisfactory, with no signs of deterioration.

Fire on Shipboard.—The fire-warning signal apparatus, which has now for upwards of twelve months been fitted experimentally on board the unarmoured screw-frigate *Mersey*, at Portsmouth, by Mr. West, electrician, of London, has been practically tested in its action under the superintendence of Captain W. C. Chamberlain, the officer in command of Her Majesty's ship *Asia*, and the steam reserve at that port. The principle of the system introduced by Mr. West is to distribute over the ship's hold in certain protected positions, a number of calorimeters, which are connected by wires with a voltaic battery, an alarm bell, and a dial plate in the captain's cabin. The calorimeters are simply metal bottles partly filled with mercury, and fitted with boxwood stoppers. Through the stopper projects downward the end of a copper wire, which is suspended at such a distance from the surface of the mercury, that it requires a fixed degree of heat to expand the mercury, and bring it in contact with the end of the copper wire. This done, the electrical circuit is completed, the alarm-bell in the captain's cabin is rung, and a flap on the dial-plate flying up, exhibits a number which gives the exact portion of the ship's hold in which the extra heat is generating. The part in the *Mersey's* hold selected to test the principle, was the handing-room of the after magazine—the calorimeters there being fixed to the beams, and their "temperature distance," if the space between the ends of the copper wire, and the surface of the mercury, may be so called, fixed at 154 degrees. Fires were lighted in stoves in the handing-room, and its temperature increased by these means to 175 degrees, when the calorimeters acted, and transmitted the signal to the alarm-bell, and the dial-plate in the captain's cabin in the most unmistakable manner. Experience will no doubt overcome the present difficulties of adjustment, and the difference between the intended and actual temperature be reduced considerably below 21 degrees which we find in this experiment.

Genius.—Those who desire to see genius in its green old age, can gratify their curiosity, and another, a nobler feeling, by calling on Mr. W. H. James, C.E. This gentleman, the *Mining Journal* opportunely reminds us, is the pioneer of railways. He and his father, the late William James, of Warwick, sunk a fortune of £200,000 in scientific and engineering labours, to found the railway system which we enjoy. It is a system which facilitates the business, or promotes the pleasure of our beloved Sovereign. It is the new channel for the inhabitants of the world to pour their productions into the profitable ap of commerce at half the cost of the old one. It is that immense power which anni-

hilates time and space, whenever we compare the present with the past century. Although Mr. James is nearly eighty years of age, he is occupied in perfecting the steam engine. This venerable old man may be seen at 884, Old Kent-road, London, S. You must excuse it if he does not ask you to "take a chair," for the landlord "took all" the other day for rent. Nor can he offer you "bite nor sup," simply because he is without food; and as the old man slumbers at night on the bare boards, in the absence of a more congenial couch, his clothes may appear rather soiled—in rags. Pride must not be permitted to smother these facts, for truth demands them. Pride should rather urge men to recognise the claims of genius, and to admit, in this case, its claims on their prompt sympathy. The noble minded and truly generous, to whom we address ourselves, need no homily to advance our argument; and the selfish deserve none. Where is now your "loose gold," ye who have been enriched by railways; and where is the man in the civilised portion of creation who has not profited by railways? Go, by all means, and see the venerated genius, having first "put money in thy purse," it may possibly ooze out there in a pleasurable stream of genial sympathy, the remembrance of which must be a perpetual source of satisfaction. Go.

Everything approaches perfect readiness for opening the Cannon-street Station on the 1st September. This will be a great event for the City, and then the thronged traffic of Fleet-street and the Strand. Trains are expected to run every five minutes to and from the Charing Cross Station. The distance, being short, may be run in less than ten minutes.

Elias Howe, the patentee of the sewing machine needle, announces that he does not intend to apply for a renewal of his patent, on the ground that he has made by it a million and a half dollars, which he regards as fortune enough for one man.

The Galchog and Northop Coal Company (Limited) have succeeded in finding the main coal three yards thick by boring. This discovery proves a considerable extension northerly of the Buckley, Maesygrug, and Northop Hall range of coals, and there is the strongest reason for anticipating at some future day that these important coal seams will be found to underlay nearly the whole of the flat country surrounding Northop.—*Flint County Chronicle.*

NAVAL ENGINEERING.

The "Bellerophon."—It appears that this man-of-war steamer which has been su h excellent stock in trade for querulous politicians, ran the measured mile, in Stokes Bay, on the 16th ult, in 4 min. 22 sec., which gives 13·740 knots per hour. She had been loaded down to 21ft. 8in. forward, and 26ft. 6in. aft. The weather was unfavourable, and the further trial postponed. When the trial was resumed on the following day we find the mean of means=14·2, and the official mean of means=14·170. This result may be not only highly favourable, but perfectly conclusive also.

The Iron Clads.—The changes have been frequently rung on the merits of the iron clads, and mathematicians have given the positive thicknesses, of the protecting iron and wood. The recent small affair between the Italian and the Austrian fleets, goes to determine the impenetrability of 4½ inch plates on a broadside, even to a 300lb. Armstrong gun. We are not disposed to attach much importance, however, to the practice of beligerents who remain unknown to science in relation to Naval warfare, however eager we may be for the decisions of experience on this very expensive question.

STEAM SHIPPING.

Registered Steam Vessels.—There were, according to a return recently issued, 2628 steam vessels registered on or before 1st January last, the registered tonnage being 803,419, and the gross tonnage 1,160,777. The vessel which stands No. 1 on the register is the *Beaver*, of 100 tons, belonging to the Hudson's Bay Company. She was built in 1835, but there are registered steamers much older than her. The *Commerce* of Sligo, a small vessel of 44 tons, was built in 1824, and appears to be the oldest registered steamship. There were several other steamers built between that time and the year 1835.

New Mode of Correcting Compass Variations.—Few things are more annoying to the mariner than the compass variations which, especially in the navigation of iron ships, he has to provide against. An extremely simple and ingenious mode of ascertaining the deviation has, however, been devised by a naval commander connected with the Naval Academy at Annapolis, Maryland, U.S., which will remove all difficulty in the matter. It is proposed to take an ordinary compass card, and erect upon its centre a fine copper wire, from 4 to 6 or 8 inches in height, and perpendicular to its plane. At the moment of the sun's meridian passage, as indicated by the noon observation for latitude, note the direction of the shadow cast by the wire on the compass card. The angle contained between this direction and that of the north and south line of the card will give the variation and local attraction combined. Small errors are involved in this method, but the approximation is close enough for the purpose for which it is intended. As there would, of course, be no difficulty in making this wire a permanent fixture to the card, it will be obvious that this arrangement would enable the deviation of the compass to be daily tested.—*Mining Journal.*

LAUNCHES.

New Steamers.—Messrs. Wm. Denny and Brothers launched on the 1st ult., the screw Steamer *Diana*, for the Austrian Lloyd's Steam Navigation Company. The *Diana* is 1,622 tons B.M.:—Length, 270ft.; breadth, moulded, 35ft.; depth, moulded, 24½ft. Engines supplied by Messrs Denny and Co., of 250 horse-power nominal.

An Iron Screw Steamer named the *Needle-Gun*, was recently launched from the yard of Messrs T. R. Oswald and Co., Pallion. The vessel is 1,281 tons builders' measure, and classed 18 years at Liverpool Lloyd's. She is to be brig-rigged, with a spar deck, and of the following dimensions:—Length of keel, 240ft.; over all, 250ft.; beam, 33ft.; hold, 24ft. She is built with a ram-shaped stem; her engines, of 150 horse-power, are by Mr. George Clark. She has a double bottom for water ballast, fitted with patent steam windlass, and though intended for the Mediterranean trade, she will have good cabin accommodation for 20 passengers.

Mr. James Laing has launched, on the Wear, the *Sherburn*, a screw steamer, intended for the coal trade, of the following dimensions:...Length, 196ft. 6in.; breadth, 28ft 8in.; depth, 16ft.; 900 tons N.N. and 950 B.M. Her engines, by Mr. Geo. Clark, Monkwearmouth, are of 90 horse-power nominal.

The "Garonne" (s s), built by Messrs. C. and W. Earle, has made her trial trip. The course run over was from the yard down to Spurn and back to Grimsby. The vessel made 12½ knots per hour by the log. The *Garonne* is 215ft. long on the loadline, breadth, 25ft., depth, 16ft. 6in., and has two engines of 90 horse-power. The trip was very satisfactory.

TELEGRAPHIC ENGINEERING.

The Atlantic Cable.—The cable started at once into business with the utmost promptitude, and with high rates. Twenty pounds for twenty words, a sum equal to 150 dollars in Federal currency, becomes a heavy charge when the addresses of sender and the receiver, are to be included and paid for. Notwithstanding this, on the same afternoon that the cable was announced at New York as open for business, twenty messages were sent in for transmission, and the payment was 3046 dollars. On the second day 2157 dollars were received for messages, and 1313 dollars on the third day. We hear of one message being sent hence to New York, for which no less a sum than £1,000 or, say, 5,000 dollars was paid. The message contained the speech of the King of Prussia. Both ends of the cable are now safe moored on British ground.

The Atlantic Telegraph Cable.—It affords us considerable pleasure to announce the fact, that the cable remains in a state of perfection, and is rapidly and efficiently performing its duties. Hitherto the public have not been particularly edified by the operations of the cable, beyond the compliments and the congratulations of those distinguished persons who have felt it to be their duty to avail themselves of the opportunity.

RAILWAYS.

Ouse Valley Railway.—The contractors for these lines have not only commenced, but are pushing on the works vigorously at both ends. Considerable progress is being made in the large cuttings near Lindfield, and the bridges are being built rapidly. On the Ardingly-road a new and extensive village has sprung up almost like magic, consisting of good and substantial cottages erected by the contractors for their workmen, with stables, workshops, and everything complete, and at the Uckfield end the works are going on quite as vigorously.—*Brighton Guardian.*

An important concession has been made by the Midland Railway in granting through rates from the various collieries in South Yorkshire to all stations on the Eastern Counties line. This will be the means of opening up new markets for the produce of the district, to the further development of its vast mineral wealth. It is confidently expected that the Great Northern will adopt a similar course, seeing the industry they have used to keep the Great Eastern out of the field, and preserve a huge monoply.

In an excellent paper, from a practical point of view, recently read by Mr. R. Price Williams, before the Institute of Civil Engineers, some facts were adduced, in illustration of the wear and tear of permanent way. It was shown that during a period of thirteen years, most of the Great Northern up-line between Pottersbar and Hornsey, where there are heavy descending gradients,* has been renewed not less than three times, giving an average of only three and a half years as the "life of a rail," under heavy coal and passenger traffic worked at high speeds. That it is "pace that kills" as well as the weight, is obvious from another fact stated by Mr. Williams with respect to the Lancashire and Yorkshire line, where an equal number of trains of about the same tonnage, as in the case of the Great Northern line were worked at low speeds over a portion of railway between Bury and Accrington, but there the rails lasted as long as seven and a quarter years.

The Indian Railway now extends from Calcutta to Delhi, a distance of 1,020 miles. It is traversed in 37 hours; it took as many days to accomplish that journey, before the construction of the railway. The numerous branches of this line, must be of immense benefit to the natives, by the economy, promptitude, and the cleanliness in which the transit of their varied and valuable products, can be carried.

The Americans have constructed a railway car 70ft. long, 10ft. wide, and 10ft high. It runs on sixteen wheels, and affords cool, comfortable, and clean couches for sixty-four persons. The interior is fitted in carved black walnut, it is carpeted, and the seats are covered with velvet. There is a cabinet organ in the centre of the car, fragrant bouquets are suspended from its roof, and six large lamps, diffuse their light throughout the night. The proprietors are building twenty more, at a cost of 20,000 dollaes.

Consider the gross injustice that would have been done in the case of one of our leading and most prosperous railway companies had it a few years ago been under the provisions of the bankruptcy laws. At that time an important company was in great distress, and for several successive half-years it had no dividend to give, and its stock in those early and unfortunate days was down below 20 per cent., or 80 per cent. discount. If the company in question had been sold up, what rank injustice would have been done the shareholders, whose stock is now at a high premium! It is the nature of railway property to progress in traffic receipts. Railways do not at once acquire their full traffic, and some of the best railway properties have been poor on their first opening. Happily also the bankruptcy laws do not apply to railways in Canada, otherwise the Grand Trunk railway would have been sold up, and all the bondholders below the second Preference, as well as the ordinary shareholders, would doubtless have lost their property, yet there is every reason to believe that in the course of a very few years more the Grand Trunk will be one of the best of railways for paying. At home we have the London, Chatham, and Dover railway unable in the panic of 1866 to pay loans falling due. These loans are very small in regard to the capital of the whole concern. What a monstrous injustice it would have been to sell up the line in order to meet the engagements to these few creditors, who will suffer nothing more than a little delay in the payment of their claims. The London, Chatham, and Dover will be prosperous in time, and therefore we say to have broken it up prematurely would be a crying wrong.—*Herapath's Journal.*

The amount paid as duty by the railways in the year ending the 31st March last was £463,022 17s. 1¾d.

North British Railway—The Waverley Route.—A short time ago an action was brought by the Midland and North British Railway Companies against the London and North-Western and other Companies, for the purpose of determining the relative claim of each to traffic receipts in the Clearing-House, under the agreement known as the "English and Scottish Traffic Agreement," terminated in favour of the first named Company. We believe that the decree made by the Vice-Chancellor in this case has been entered without notice of appeal by the defendants; and the immediate effect of this has been the distribution, among the companies who are parties to that agreement, of traffic receipts to the amount of between £700,000 and £800,000—not an unseasonable incident in these days of dear money. Another consequence of the decision thus rendered final is the removal of the difficulties which, by what seems to have been a strained interpretation of the agreement, were thrown by some of the companies in the way of through booking and through running, in connection with the Waverley Route, between England and Scotland. The decision does not, we believe, render through booking, and running of through carriages, obligatory; but it compels the Clearing-House to recognise the Waverley Route as an open one, and to allot to the companies interested in it—the North British and Midland, as well as the London and North-Western—a proportion of mileage on all traffic; whereas under the state of things existing before the case was decided, the former companies were unable to draw the money earned on their own lines. The gain to public convenience in the extension by the London and North-Western of through facilities by this route, which is almost certain to follow their non-appeal against the decision, will also be considerable.

Cutting of the First Sod of the Lancashire Union Railways.—The first sod of the Lancashire Union Railways—a scheme intended to open up more fully the mineral districts of South Lancashire—was cut on Tuesday, the 31st ult., in the township of Naigh, near Wigan, by Richard Moon, Esq., the chairman of the directors of the London and North-Western Company.

*It occurs to us that there is an element of destruction which is conspicuous by its absence, and deserves in its importance, to be admitted, when we recognise "heavy descending gradients," and "heavy loads," and "high speeds." For, under such circumstances, what would become of such trains if permitted to accumulate velocity unchecked, whilst this *checking* must be done at the expense of the rails and of the tyers, and that commensurate with the required friction between these two, of course *more* than is due to a mere rolling motion of the wheel on the level rail.

The following interesting table has been compiled by W. Galt, Esq., at the request of the Royal Commission on Railways.

Average fares per 100 miles.

	Ordinary Trains. Third-class.	Ordinary Trains. Second-class.	Ordinary Trains. First-class.	Express Trains. Second-class.	Express Trains. First-class.
Russia	3 0	10 10	14 5		
Prussia	3 2	10 0	12 6	12 0	14 0
The Rhine	3 10	8 9	11 10		
Norway	4 6	9 0	13 0		
Sweden	4 9	7 6	11 0	10 0	13 0
Bavaria	4 10	7 0	10 0		
Belgium	5 0	7 6	10 3	9 0	12 6
Wurtemberg	5 1	6 8	10 3		
Denmark	6 0	9 0	12 0		
Spain	6 3	10 5	14 7		
Austria	6 6	10 0	13 0		
Saxony	6 8	8 3	21 0		
Switzerland	6 8	9 0	12 0		
Italy	7 0	10 6	14 0	12 0	16 0
Portugal	7 0	10 0	13 3		
Holland	7 0	10 6	14 0		
France	7 6	11 0	14 6	13 0	16 8
Great Britain and Ireland	8 0	13 4	18 6	16 8	21 0

It must, however, be borne in mind, that in those foreign countries where the railways do not belong to the State, the shareholders receive considerable Government assistance in consideration of their being obliged to adopt a low tariff.

The South Devon Railway.—All who know anything by experience of the late Mr. Brunel, are unanimous about his skill, and business tact, and are content to speak in terms of praise of both. That celebrated engineer left several monumental evidences of his ability; and, at least one, of a hasty, immature conclusion, and that one was the South Devon Railway. We need not go farther than notice the great sacrifice of capital, which was the consequence of an error of Brunel's judgment in adopting the atmospheric principle. The abandonment of his designs, left a legacy of unremitting toil to the board of hard working directors. The chairman, T. Gill, Esq., soon succombed to the arduous task. He was succeeded by T. Woollcombe, Esq., who has remained at his post, with unflinching assiduity, and corresponding success, nearly twenty years. The South Devon was merely a single line, it is we believe, a double line now, or nearly so, and this has been done mainly out of revenue. The revenue for the half year, ending 30 of June last, was £109,172; of the corresponding half of 1865 it was £101,518, showing an increase of £7,654. The profit amounted to £49,311 against £47,615 for the same half of 1865. The profit is not large, certainly, but it is progressive, and so is the daily improvement of the line. By the wise policy so perseveringly pursued, we may yet see this line free from those embarassments in which it was plunged at the very onset of its career, and against which, although diminishing, it has had to struggle ever since. The highest meed of praise is due to its intelligent and persevering board of directors, and to the acumen of their chairman, who is identified with its every measure of progress and of economy.

DOCKS, HARBOURS, BRIDGES.

Fall of a Suspension Bridge.—The Rotonde Suspension Bridge at Nantes, France, gave way a few days back, while a herd of forty bullocks was passing over. The cattle had been divided into two portions, of which the first with two men got safely across; but the second lot with a driver, named Tertrois, were precipitated into the water. The man lost his life, not from drowning, but from the animals falling on him. Several of the latter also perished. The bridge was very old.

The Directors of the Cookham Bridge Company having advertised for plans and tenders, received no less than thirty-seven different schemes, with estimates varying from £1,900 to £27,000. From this vast collection they selected three, Mr. Pease, of Darlington; Messrs. Peto and Betts, London; and Mr. John Pinchbeck, of 27, Leadenhall-street. Ultimately Mr. Pease's tender was accepted £2,640; Messrs. Peto and Betts, and Mr. Pinchbeck receiving the two prizes of £20 and £10.

Portsmouth.—New Mercantile Docks.—It is rumoured that a commercial basin and docks are being projected at Portsmouth. Government are demolishing, the old fortifications to which the name only applied, as they are positively useless; the old limits being outgrown and surrounded by villas and other descriptions of houses, into which the guns on the ramparts must be discharged, if at all. The mill-dam and its corn-mill are designed to make room for capacious docks, which will cover some 26 acres. An entrance lock 950ft. long and 100ft. wide, with a caisson at the entrance, is to be formed between the gunwharves, the northern of which will thereby acquire an increased area and wharfage. The lock will communicate with the harbour at its western end. The outer basin will have an area of 15 acres, with 3,130ft. of wharfage, and will be connected with four graving docks, averaging 456ft. in length and 100ft. wide, capable of receiving any of Her Majesty's steamers in the event of an emergency. The inner basin, separated from the outer by a caisson will have an area of 11 acres, with 2,975ft. of wharfage. Both inner and outer basins will have direct communication with the railway, and a separate line of rails is intended to be laid down for the exclusive use of the gunwharves. Of course this will occasion another system of road ways in the immediate locality. We should not be surprised if the military were invited to occupy another parade ground, and leave the fine area of Southsea Common to be occupied as docks, which would prove a profitable investment for all concerned, and supply a great want to our mercantile marine. It would also be an immense boon to the rapidly increasing and very important locality of Portsmouth. We are under the impression, that the governmental authorities could not hesitate in appreciating the advantage which must be a gain to the services, naval and military, in maturing the plan now shadowed forth.

MINES, METALLURGY, &c.

New Zealand.—A mighty change seems to be dawning over the destiny of New Zealand. The sand on its sea-shore, the rivers flowing through the length and breadth of its land, and the mountain ranges from the north to the south of each island, all seem impregnated with gold to a greater or less degree. The Hokitika diggings, since they have been worked, a period of only a few months, have turned out about £700,000 worth of the precious metal. A correspondent from that locality writes as follows: "And as to the reality of the ground as a gold field, I think there cannot be much doubt, when, within one month, more than 45,000ozs. of gold were exported, and I doubt not the present month will be far in excess of this. A few days ago I happened to be out riding, and selected the beach north of the town on which to take exercise, and found the whole of the beach for miles was being occupied with diggers, who are mining just above high water mark, and are washing out of the sea-sand sufficient gold to produce from £5 to £20 per week per man. In fact, nearly the whole coast from the Grey River down to Bruce Bay is a magnificent gold field; and inland, too, for miles, men are gradually extending the field. During the last fortnight there have been several rushes up to the foot of the snow-capped Southern Alps, where the diggers are finding good payable gold The total value of New Zealand gold exported from the colony up to the 30th of June last was £7,646,809, and the number of ounces was 1,947,667. The principal localities from whence the gold has been obtained hitherto have been Otago and Christchurch provinces, but the whole of New Zealand is believed by geologists to be auriferous."—*American Journal of Mining.*

Discovery in Iron.—At the closing meeting of the Royal Society's session, there was a paper by the Master of the Mint, which is likely to engage the attention of chemists and metallurgists, for it carries on, and with striking results, the researches arising out of Mr. Graham's important discovery of dialysis. Treating of the absorption and dialytic separation of gases by colloid septa, the first part of the paper gives the results obtained by a septum of caoutchouc, and the second part those of different metallic septa at a red heat. It has long been known that palladium and some other metals, when heated, absorb gases. Mr. Graham now finds that palladium will take up several hundred times its bulk of hydrogen, and that iron at a low red heat absorbs a considerable quantity of carbonic oxide; and that, contrary to a long-standing belief, this gas does not act on the surface of the metal only, but permeates its entire substance. This fact is particularly interesting to metallurgists. Having taken up the gas, the iron will retain it for any length of time, and in this condition is best adapted for conversion into steel, as by the permeation of the carbonic oxide the subsequent process of carbonisation is largely facilitated. Hence arises the suggestion that the process of acieration would be best accomplished by changes of temperature; a low red heat to fill the iron with carbonic oxide, after which it may be put away if required, to await the final process at a high temperature of conversion into steel. Concerning another form of iron, Mr. Graham remarks that wrought iron, in the course of its preparation, "may be supposed to include six or eight times its volume of carbonic oxide gas, which is carried about for ever after. How the qualities of iron," he asks, "are affected by the presence of such a substance, no way metallic in its characters, locked up in so strange a way, but capable of re-appearing at any time with the elastic tension of a gas, is a subject which metallurgists may find worthy of investigation." It would not be easy to overrate the importance of the paper of which we have given here so brief a sketch, for it is remarkably suggestive and original throughout. When published in the *Philosophical Transactions*, with all the details, it will secure the attention it deserves. If Mr. Graham had never written more than this paper, it would suffice to place him in the foremost rank of the chemists of Europe; and it may be that metallurgists will now be ready to claim him as one of themselves for what he says about iron and other metals.

BOILER EXPLOSIONS.

The Daily Papers give us the following account of a most singular occurrence :—"A fatal explosion took place on Saturday morning, 28th July, at Phœnix, better known as Scotia Colliery, Tunstall, Staffordshire, belonging to Mr. Hugh Henshall Williamson. Powerful machinery had but just been erected at the bottom of the new road from Burslem to Tunstall, connected with which were two boilers, 36ft. in length and 9ft. in diameter, raised on a foundation of solid brickwork. One of these boilers was completed on the Wednesday morning, and with that the engine was set to work. At twenty minutes past seven o'clock on Saturday, while several persons were engaged in fixing the other boiler, and while two men were actually at work inside it, the boiler which was at work burst with terrible effect, making the whole neighbourhood shake. The entire end of the boiler was blown out. The inner tube was hurled about a hundred yards distance, while the boiler itself leaped from its bed into the air upwards of a hundred yards. It fell into a large heap of refuse. The other boiler, with two men inside, was sent fifty yards along the road. The adjoining building was demolished, the stone and brickwork being torn up, and sent in terrible showers, which covered the ground in every direction. The engine-driver, Stephen Chadwick, who is married and has three children, was literally blown to pieces. A boilermaker, named Abel Mayer, a young married man, who was at work at an unfinished boiler, and who was found shockingly crushed amid the wreck, expired soon after. The names of the injured men are—Elijah Mayer, engineer, father of one of the men killed; James Pitts and Thomas Dillon, labourers; Joseph Humphreys, and a men named Braddeley, were inside the unfinished boiler, and are but slightly hurt; and John Smith, bricklayer, who is so seriously injured that no hopes are entertained of his recovery; W. Clay, struck by a flying missile; and a man named Riley, injured by a horse which took fright at the explosion. The tube of the boiler, which weighs some tons, was hurled right over an engine and several boilers beyond. Had this huge piece of iron fallen on these boilers, the damage would have been terribly increased by other explosions, as less heavy pieces falling upon the unfinished boiler pierced it through. The amount of damage is very great. At the coroner's inquest which followed, it was shown that this explosion of a new boiler was due to improper construction.

A Boiler Explosion of a novel character, has reduced the splendid steam-yacht of Mr. Buxton, of Danesbury Hall, to a complete wreck. The vessel was leaving the Quay Basin, Runcorn, and the captain gave the words "ease her," when, it is reported, the boiler was suddenly lifted up and carried over the tidal basin, falling at about 100yds. distance. The engineer, John Walker, was also thrown high into the air, and fell in the water, and was not recovered for an hour afterwards. His wife also was killed, and five others were seriously injured. We care not to speculate on the cause of this catastrophe, in the prospect of a legal investigation, although we may not hope for conclusive evidence in the absence of the engineer.

WATER SUPPLY.

Peebles Water Supply.—The town authorities have decided on issuing contracts for carrying out this necessity into practice. It will be conducted by Mr. Gale, C.E., of Glasgow. The water is to be brought from Meldon Burn, which is at an altitude of 724ft. above Ordnance datum, and at a distance, by the proposed line of pipe, of 8,653yds., or nearly five miles. The High-street appears to be 540ft. above Ordnance datum, or 184ft. below the proposed point of intake on the Meldon Burn. The feuing ground on the south side of the Tweed, rises to an elevation of 611ft., and it is assumed to be necessary to deliver the water at a height of 30ft. above the surface of the ground, the net available fall, for the supply of this part of the town, is reduced to 80ft. Assuming the population to consist of 3,000 inhabitants to be supplied, and allowing twenty gallons per day, the total quantity of water necessary will be 60,000 gallons daily. Presuming that the present works, at their smallest discharge, will yield five gallons per minute, or 5,000 gallons a day, then 55,000 gallons remain to be supplied. Mr. Gale is of opinion that a 5in. pipe, with a fall of 80ft. in that distance, would deliver over 60,000 gallons in twelve hours.

APPLIED CHEMISTRY.

The "Chemical News" contains the following interesting notes. M. Chevreul made a paste of white lead and water, and another of white lead and linseed oil, and placed them in separate tubes. Above the oily paste he placed water, and above the watery paste oil. The oil in the latter case displaced the water, but water did not displace the oil in the former. In corresponding experiments with clay, and pure kaolin, it was found that water would, in each case, drive out oil, but oil would not drive out water. It is very desirable to see these facts established; for, in practice, we are not unfrequently driven to substitutes by necessity. However careful we may be over a joint, a substitute invariably invites the question, *will it stand?* The facts established by M. Chevreul should invite our confidence, or suggest more appropriate materials.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated July 23rd, 1866.

1911 T. Andrews—Machines for winding or warping and drying yarns
1912 G. T. Bousfield—Manufacture of certain alkaloids derived from aniline and its homologues
1913 G. T. Bousfield—Producing and superheating steam
1914 A. Noble—Construction of segment shells
1915 G. Mountford and G. L. Loversidge—Tanning of hides and skins
1916 J. H. Johnson — Grate bars for furnaces and fireplaces

Dated July 24th, 1866.

1917 G. Davies—Manufacture of sulphate of soda and sulphate of potash
1918 W. B. Woodbury—Method of and apparatus for printing from metal
1919 W. E. Gedge—Sweeping machine
1920 T. Corhett—Reaping machines
1921 W. E. Newton — Machinery for burnishing enamelled paper
1922 W. E. Newton—Machinery for hulling and finishing rice
1923 W. E. Kochs—Construction of railway carriages
1924 E. P. H. Vaughan—Preventing incrustation in steam boilers
1925 F. Palmer—Improvements in ships or vessels of war

Dated July 25th, 1866.

1926 J. H. Selwyn — Shaping metals and other ductile materials
1927 H. Prince—Motive power engines
1928 J. Strang—Tubes and skewers for cops
1929 J. Bordinghaus—Production of fancy or figure weaving
1930 J. Hinks and J. Hinks—Lamps for burning petroleum oil and other volatile liquid hydrocarbons
1931 H. Lea and T. Lane—Looms for weaving
1932 H. Calisher—Improvements in firearms
1933 J. Livesey—Refining cast iron
1934 C. E. Brooman—Treating armour plates to render them invisible
1935 J. Vavasseur—Compressors for receiving and absorbing the recoil of guns and other ordnance
1936 G. B. Woodruff—Construction of sewing machines
1937 W. E. Newton—Dyeing and hardening dyed woods
1938 W. E. Newton—Treating iron for the purpose of converting it into steel or hard metal

Dated July 26th, 1866.

1939 W. E. Kochs—Steam slide valves for locomotive, marine, and general steam engines, and water valves
1940 H. A. Bonneville — Explosive compound mixture
1941 H. A. Bonneville—Steam generators
1942 W. Toms—Rein clip or holder
1943 E. H. Bentall—Machinery for sharpening saws
1944 J. W. Hoffman and G. R. Wilson—Lowering and raising window blinds
1945 I. Haynin—Buttons or studs to be used for fastening the shirt
1946 T. Adams—Motive power engine
1947 J. P. Hubbard and C. Adams—Sewing machines
1948 W. Weldon—Manufacture of chlorine

Dated July 27th, 1866.

1949 J. C. Haddan—Improvements in anchors
1950 A. V. Mathieu—Apparatus for irrigating the intestines
1951 W. Seaton—Permanent way of railways
1952 W. Stroudley — Locking facing points or switches of railways
1953 J. Orr—Ornamental weaving
1954 G. Speight—Collars for the neck, and wristbands

Dated July 28th, 1866.

1955 C. D. Abel—Regulating the supply of water and other fluids to steam boilers and other receptacles
1956 P. Griess and H. Caro—Preparation of bodies in which nitrogen is substituted for hydrogen
1957 J. Phillips-Smith—Traction engines
1958 W. Clark—Rotary engines
1959 J. Adams—Construction of revolver firearms
1960 W. Richards—Breech-loading firearms

Dated July 30th, 1866.

1961 J. J. Wheeler—Tipping walking sticks
1962 J. Pickering—Hot blast for smelting and other furnaces
1963 J. McKenzie, T. Clunes, and W. Holland—Actuating and regulating railway points and signals
1964 T. Greenwood—Manufacture of boots and shoes

Dated July 31st, 1866.

1965 T. Bibby and J. Bibby—Manufacturing paper bags
1966 A. Paraf—Application to medicine, for beverages and for industrial purposes, of a new gaseous water
1967 T. Bullough and G. Openshaw—Shuttles used for weaving
1968 J. A. Birkbeck—Washing coal, ores, and other minerals
1969 F. C. Hills—Manufacture of oxalic acid
1970 J. J. Bodmer—Manufacture of cements, concretes, and artificial stone
1971 G. T. Bousfield—Manufacture of fuel from peat and such like vegetable matter
1972 W. E. Gedge—Imitating mother of pearl upon various surfaces
1973 W. E. Gedge—Fastening intended to replace the ordinary screws and nuts in bedsteads and articles of furniture generally
1974 W. E. Gedge—Spade or digging implement

Dated August 1st, 1866.

1975 J. Poole—Metallic hoops for casks
1976 W. Stokes and C. Faulkner—Breech-loading firearms, and cartridges for breech-loading firearms
1977 E. J. Billing—Improvements in safes
1978 A. Paraf—Improvements in deoxidation and precipitation
1979 W. Beaumont and W. McMaster— Holding and releasing cords, chains, ropes, and bands
1980 J. Sawyer and F. Bauman—Manufacture of paper pulp from wood and other fibrous materials
1981 E. Gilman—Improved velocipede
1982 J. Robinson—Improvements in the Giffard injector
1983 G. H. Couch—Tenoning and shouldering machine
1984 J. Parry and R. Morris—Machinery for sharpening saws
1985 W. E. Newton—Method of promoting combustion of fuel in steam boiler furnaces and other furnaces
1986 S. Chatwood, J. Sturgeon, and T. Sturgeon—Hammers and mechanism used therewith
1987 J. Talbot—Improvements in cutting files

Dated August 2nd, 1866.

1988 C. N. Plantrou—Machinery for carding, combing, and cleaning cotton and other fibrous substances
1989 W. A. Marshall—Method for insulating and protecting electric telegraph wires for submarine, subterranean, and other lines with improvements in the machinery and in the process and material
1990 E. Lamb—Construction of fire escapes
1991 J. B. Ham—Corn rick stand and waterproof cover
1992 W. Furness and W. Bray—Machinery for cutting files and rasps
1993 I. E. Chillcott—Construction of safes
1994 J. T. H. Richardson—Moulding or pressing glass
1995 J. H. Johnson—Implement for the use of boot and shoe makers
1996 W. E. Newton—Construction of ordnance
1997 G. Campbell—Raising aëriform and other fluids
1998 G. T. Bousfield—Carding engines
1999 H. J. Batchelder—Manufacture of horseshoes or various other articles
2000 J. G. Avery—Improvements in churns
2001 S. T. Armstrong—Machinery for cutting dovetail joints
2002 G. W. Fair—Smoke consuming heater

Dated August 3rd, 1866.

2003 N. Kilvert — Machinery for amalgamating, purifying, cooling, and bleaching lard or other similar materials
2004 J. Whittaker—Ladies' dress suspenders
2005 T. Campbell and H. Coffey—Staining or coating the surfaces of paper with colour or other material
2006 W. Deakin and J. B. Johnson—Means for the manufacture of tubular and hollow cylindrical bodies
2007 J. H. Johnson—Mode of securing corks and stoppers in the necks or mouths of bottles, jars, and other vessels
2008 W. H. K. Mack—Apparatus to be used for fishing
2009 C. Ritchie—Ships' furniture
2010 P. Murray—Machinery for forming the teeth of bevel wheels

Dated August 4th, 1866.

2011 C. Pratt and J. Pratt—Motive power engines
2012 W. Hartcliffe and T. H. Lee—Manufacture of flat linked chains
2013 J. Boyd—Winding apparatus
2014 W. Jackson—Snuffiating accumulating pump or hydraulic engine
2015 A. Vescovali—Increasing the adhesion of locomotive engine wheels to their rails
2016 T. Wilson—Breech-loading firearms
2017 I. Dimock—Sewing machines

Dated August 6th, 1866

2018 J. W. Hoffman and G. R. Wilson — Metallic mirrors
2019 P. M. Parsons—Permanent way of railways
2020 W. Smith—Horse road scraper and brush
2021 E. Lamb—Construction of fire escapes
2022 E. Lamb—Construction of bridges
2023 R. Medcalf and W. Nicholls—Couplings or connections
2024 J. H. Johnson—Stamping, crushing, and pulverising ores and other hard substances
2025 J. Hamilton—Artificial material for producing gas for illuminating purposes
2026 W. E. Newton—Manufacture of carbonates and bi-carbonates of soda and potash
2027 W. R. Lake—Improvements in steps or foot bearings for spindles

Dated August 7th, 1866.

2028 G. B. Windle—Construction of portable lanterns
2029 E. Lywood—Instrument for facilitating the ascertaining the temperature of hay, &c.
2030 G. Zanni—Mechanism for obtaining and applying motive power
2031 W. Bottomley—Machinery for fulling woollen cloths
2032 G. Warriner and W. H. Stallard—Improved lamp
2033 W. R. Lake—Machinery for removing the seeds or stones from raisins and other dried fruits
2034 J. N. Browne—Improvements in preserving wood
2035 C. A. McEvoy—Torpedoes or submarine explosive instruments
2036 W. E. Newton—Chucks for turning lathes and other tools

Dated August 8th, 1866.

2037 J. Sibley—Machinery for spinning and doubling cotton or other fibrous material
2038 Sir J. Benson—Improvements in the processes of jointing together armour plates used for covering and defending ships, &c.
2039 H. Holland —Manufacture of umbrellas and parasols
2040 G. Davies—Printing on glass and other materials
2041 W. Clark—Double hydrostatic scales for determining the load of ships or boats
2042 E. H. D. Ingé—Mode of applying covers or awnings to garden and other similar seats
2043 P. Spence—Production of sal ammoniac in a commercial form
2044 J. Robinson and J. Smith— Applying motive power to saw frames
2045 W. Hoare—Apparatus for damping direction and other labels
2046 A. Oldroyd and P. A. Godefroy—Treatment of jute

Dated August 9th, 1866.

2047 J. Turner—Wet gas meters
2048 G. B. Harkes—Construction of rotatory steam engines
2049 J. Gathercole—Machinery for making envelopes and paper and other bags
2050 J. Brown and J. Hilun — Improvements in jacquard machines
2051 B. Donnet—Movable shuttle distributor applicable to fringe machinery and improvements in fringe machines
2052 W. R. Lake—Improved telegraphic cable
2053 C. T. Judkins—Sewing machines
2054 W. Clark—Musical instruments and notation
2055 J. Clay—Improvements in saddles
2056 A. V. Newton—Machinery for manufacturing envelopes
2057 W. E. Gedge—Construction of buckles or fastenings for braces and other articles

Dated August 10th, 1866.

2058 L. E. Williams—Explosive shells
2059 C. F. Cotterill—Manufacture of earthenware and other pipes
2060 M. A. Muir and J. McIlwham — Making moulds for casting ground screws for fence and other posts, and apparatus therefor
2061 G. W. Rendel—Manufacture of coiled iron tubes or cylinders used in the construction of cannon

Dated August 11th, 1866.

2062 W. Mosley—Improvements in furnaces
2063 J. Collins and A. D. Campbell—Improvements in stamps for producing impressions
2064 J. E. Keirby—Improvements in packing for steam, water, air, and gas tight joints
2065 H. G. Craig—Improved needle gun
2066 W. Clark—Improvements in the utilisation of chlorid of manganese, &c.
2067 J. I. Ensley—Manufacturing illuminating gas and producing bone black and other valuable residuum
2068 B. F. Weatherdon—Thermometers and pyrometers

Dated August 13th, 1866.

2069 E. A. Cowper—Machinery for sewing
2070 R. Leigh—Improved direct acting lift or tilt hammer
2071 H. Bell—Improvements in violins, &c.
2072 D. Marchal—Combustion and prevention of smoke, and increasing the heating power of fuel
2073 W. E. Newton—Breech-loading firearms
2074 E. Whalley—Machinery to be employed in the manufacture of banding of twine from cotton, &c
2075 H. Sanderson—Manufacture of knives and forks
2076 J. Hathwell—Implement for ploughing, digging, and cultivating land

Dated August 14th, 1866.

2077 S. Robotham—Making caustic soda from common salt or chloride of sodium by the action of lead or its oxide, and recovering the lead as oxide for use in making caustic soda from common salt
2078 R. Wilson and W. Martin—Construction and mode of working calenders and mangles used in finishing textile fabrics
2079 R. Bagley—Improved screw stock
2080 W. E. Gedge—Improved horse shoe
2081 E. Page—Means for the manufacture of bricks and tiles
2082 A. V. Newton—Mode of fastening boiler tubes
2083 J. A. Wanklyn and A. Paraf—Production of green colouring matters for dyeing and printing textile fabrics and yarns
2084 C. F. Baxter—Improvements in waterproofing textile fabrics, and in preserving leather, &c.

Dated August 15th, 1866.

2085 W. J. Current—Improved and simplified code of signals, to be used by day or night, at sea or upon land, with flags and ventilating lamps
2086 J. B. Edmondson and J. Carson—Presses for printing the date or other particulars on railway and other tickets
2087 S. Alley—Drilling machines
2088 R. J. Worth—Direct acting steam pumps
2089 H. J. Petty and C. F. Sayer—Method for the working perpendicular sliding sashes, &c., by the aid of spring rollers
2090 J. A. Turner—Woven fabrics
2091 E. W. De Rusett and R. F. Dale—Improvements in pumps and in adapting them for propelling vessels and for other purposes
2092 W. Brookes—Cutting, grinding, and finishing marble and other similar materials
2093 H. B. White—Apparatus for detaching ships' boats
2094 T. Fleet, W. Payne, and F. Rock—Self-acting fixed and repeating portable means for signalling on railways
2095 J. Webster—Coating and recovering metals from chlorides and other solutions of metals
2096 C. Brown—Consuming smoke from gas and other lamps
2097 J. W. Hoffman and G. R. Wilson—Communication between the guard and passengers or any other persons in a railway carriage or train
2098 J. W. Hoffman and G. R. Wilson—Pickle piercer
2099 J. W. Hoffman and G. R. Wilson—Pocket kite
2100 W. Shaw and J. Connell — Manufacture of elastic and other fabrics
2101 J. Cameron—Manufacture of iron and steel
2102 J. Cooper—Improvements in battens

Dated August 16th, 1866.

2103 H. A. Bonneville—Manufacture of the wheels of carriages for conveying coals and other minerals in the working of mines
2104 W. Clark—Rudders for ships and other water crafts
2105 W. R. Lake—Heating apparatus
2106 W. C. Gibson—Method of protecting labels from injury
2107 A. Kuhne — Purification of water, and disinfection and preservation of putrescent and putrescible matters
2108 W. Smith—Improvement applicable to reaping machines
2109 D. Rolls—Manufacture of envelopes and of paper for making envelopes
2110 G. Payne—Treating fatty and oily matters
2111 J. Holly—Railway brakes

Dated August 17th, 1866.

2112 A. L. Wood—Improvements in sewing machines
2113 W. Trantner—Improvements in firearms
2114 E. T. Hughes—Application of chlorine for the condensation of nitrous gas and improvements in the apparatus connected therewith
2115 A. Paraf—Use and application of an inorganic glyceric ether
2116 J. Clark—Improvements in rails for railways
2117 A. V. Newton—Construction of bale fastening
2118 J. H. Johnson—Stuffing for mattresses, chair seats, and other like purposes
2119 W. Clark—Puddling furnaces
2120 A. Berhard—Improvements in the permanent way of railways

Dated August 18th, 1866.

2121 E. Stevens — Kitchen ranges, ovens, and steamers
2122 B. F. Weatherdon—Improved buckle
2123 W. E. Newton—Apparatus for saving life and property in cases of shipwreck
2124 R. A. E. Scott—Manufacture of hollow projectiles
2125 G. E. Moore — Filtering and purifying water and other fluids
2126 J. Abraham — Manufacture of central fire cartridges for breech loading firearms
2127 J. Varley—Steam engines
2128 S. Mortimer—Machinery for combing wool or other fibrous substances
2129 J. S. Blockey and J. Hervey—Manufacture of paper bags

Dated August 20th, 1866.

2130 T. Henderson—Material used for beds of horses and other animals
2131 S. R. Platt and E. Hartley — Slubbing and roving frames
2132 W. Greenwood—Manufacture of flocks
2133 W. Weldon—Construction of ordnance
2134 C. Bathoe—Securing or protecting corks or stoppers in bottles and other similar vessels
2135 J. Darby — Improvements in firearms of all calibre and conversion of breech-loaders into muzzle-loaders
2136 W. Taylor—Sewing machines
2137 J. H. Johnson—Obtaining motive power
2138 G. Haseltine—Inking apparatus for printing in colours
2139 R. A. E. Scott—Method of manœuvring guns

Dated August 21st, 1866.

2140 J. Murphy—Construction of springs suitable for railway carriages and for various other uses
2141 H. B. Wright—Laying and sustaining in position telegraph cables
2142 W. E. Gedge—Portable mill
2143 J. C. R. Isherwood and R. Warry—Breech-loading firearms and in cartridges for the same
2144 W. E. Newton—Making nails
2145 W. E. Newton—Distillation, rectification, and disinfection of mineral or vegetable oils
2146 J. Whitworth—Cartridges for ordnance

Dated August 22nd, 1866.

2147 J. S. Nibbs—Lamps for burning a combination of mineral and vegetable spirits
2148 W. Wield—Treating carrigeen or Irish moss, seaweed, and like plants, to reduce them into a state of powder, and in arrangements and apparatus to be used for the purpose
2149 J. Longbottom—Improved modes of ornamenting kampakaon, &c.

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ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 180.)

Chapter V. (*Continued*).

Sinkings in the Bay of Mont S. Michel, and on the North Coast of Britanny.

72. *Ancient roads in the Forest of Sciscy.*—"Two great military roads or routes, of which one started from Condato, now called Rennes, and the other from Corsoul, were re-united at Hayes de Dol, between S. Leonard and Carfantin. There they formed a single road which proceeded by La Mancelière in Baguer Pican, traversed the forest in all its length, and joined Crociatonum, the capital of the Unelli, situated apparently in the parish of Aleaume, one-quarter league from Valognes, in the Cotentin. For the rest, this desert filled with wild beasts, as history explains (prœbens altissima latibula ferarum)* "was originally scantily peopled by other creatures scarcely human, namely, by certain half savage pagans, to whom in Christian ages succeeded a crowd of anchorites, who retired to the forest to serve God more freely far from the tumult of the world. Adjoining this profound forest, was another, which was in fact only a prolongation and continuation of the former. Its proper name, if it ever had one, is unknown to us; but it is certain, by history and from the remains which are found in it still in our time, that it extended with some slight interruptions almost from the Bay of Verger, mentioned above, to Cape Frehel." So far Manet. On the authority of Dr. Hairby, in his History of Mont S. Michel, 1841, we know that the learned antiquary, M. de Gerville, says that this destroyed country was crossed by a Roman road, which led from S. Pair to Rennes. In the Bayeux tapestry (temp. William the Conqueror), there is a view of eight warriors on horseback, preceded by three men on foot, who are crossing the River Conësnon, near Mont S. Michel. This was simply a crossing on the sand, there is no reason to believe there was any such elaborately formed road as the Romans were accustomed to make, and the circumstance has nothing to do with the sinkings. The Couësnon, which is the boundary between Normandy and Britanny, used sometimes to pass on the Breton side, and sometimes on the Norman side of the Mont as the action of storms determined. A few years ago a new channel was formed for the river, faced with stone at the sides, which leaves the Mont on the Norman side of the Conësnon. The making of this channel gave rise to a circumstance which is illustrative of our subject. A French countess, one of the ancient nobility, claimed compensation for the portion of sands taken for the channel, as having been part of a former estate belonging to her family. Her claim was admitted and compromised. This channel is shown on the map by a black line; the words New Channel are a little out of place.

73. *Vast quantities of trees from the sands of Mont St. Michel, &c.*—Abbé Manet gives personal testimony in his note 26, as to "the immense quantity of trees of all species, which have been disinterred for ages from the sands of Mont S. Michel, on the coasts of Granville, and especially in the marshes of Dol, &c., where the sea does not impede the workmen. Those trees, which are commonly oaks, have preserved their form, their bark, and some of them even their leaves. Their long sojourn in the mud has, in the meantime, altered their substance a little; and given them when they are burnt, a sour odour which causes hoarseness, but when the water which has penetrated them is evaporated, their wood which was soft, becomes compact, and acquires great hardness. It takes almost the polish of ebony, which it resembles in colour; and makes very pretty furniture." It is used for espaliers and in the construction of houses, which are especially to be seen in the Isle *de Mer*, which place is in 1° 51′ W. long., and 48° 33⅓′ lat., 3½ *miles inland.* The name, of course, signifies that the place was once surrounded by the sea. The inhabitants of the marine islands near S. Malo call these trees "canaillons," the workmen call them "coërons." "During the famous hurricane of 9th January, 1735, the agitation of the sea was so great on the sandy shore of Mont S. Michel that it ejected from the sand a prodigious quantity of these logs (billes), which were always found lying from north to south, which proves, independently of history, that these trees were not thrown confusedly here and there, but that the tempest to which they owed their ruin, blew from the north."* This alleged direction of the prostrate trees is not concurred in by other authorities. Manet states, p. 36, that the shifting sands of Mont S. Michel have been penetrated in different places more than 50ft. without finding their bottom. And he says also, in a footnote on the same page, that "In 1780, according to M. Blondel, a ship was stranded near Mont S. Michel. It sunk in such a manner that it was swallowed up entire; and it all, even to the masts, disappeared in the space of a few days."

"The places named the Grand Bruyère and the Cardequint, between Mont-Dol and the Isle Mer, are especially remarkable for the acorns, beechmast, hazel nuts; &c., well preserved; which one encounters at 6, 8, and 10 [French] feet deep; from which [the abbé thinks] it is natural to conclude that the entire overthrow of the forest of Sciscy in this part, was not effected until the approach of autumn. The custom of the borderers, in order to discover the stumps, is to sound the earth with long spits of iron, and to dig in the places where the spits prove a resistance."—Manet p. 53.

74. *Farther proofs of the inundations in Britanny.*—Abbé Manet informs us in his note 50:—"It is common and notorious," says M. Briandi Bertrand, rector of S. Guinou, in the procès-verbal of the commissaries sent on the 23rd August, 1606, by the parliament of Bretagne to prove the state of the country, "that anciently the sea covered all the marshes of Dol at every high water; it reached as far as the town of Carfantin, against the cemetery, and for this reason it was called the Port of Carfantin. * * We can say also this much of this village, also called the Port, that it is at 5 or 600 toises to the south of Cendres, near Pont-Orson; and where, as a proof which dispenses with all others, one does not encounter still very near, the black earth, but that white mud, which proves the long sojourn of the ocean on all the places of which we have spoken. And what is more is, the marshes of Boncé, Ancé, and others going towards Antrain, bear themselves the symptoms of the terrible invasions of 709 and 811; and it is a fact as curious as authentic, that in 1789, at the time of the enclosure of these marshes, there were found buried in the Tangue, the remains of a barque, with a quantity of shells of the same species as those with which the sands of Mont S. Michel are filled."

75. The following extract from *The Acts of the Saints of the order of St. Benedict* confirms the fact of the former existence of the forest of Sciscy (and the same statement appears in Neustria Pia, but under dates

* Abbé Manet mentions in his note 30, the horn of a stag, with many antlers, and 19 French inches long, which was found in the recovered territory in 1814, buried 3 or 4 French feet deep. An entire head of the Urus (mentioned by Cæsar), is also said to have been found.

* See Abbé Manet's Book, p. 53. This storm, he says (p. 100), caused the sea to surmount the top of the embankment, and flooded a vast extent of Britanny.

548 and 550). It says,* "Year of Christ 565, April 16, Seculum I., p. 152, 153. From the M.S. volumes. 1. The most reverend Bishop Paterne of Poitiers. . . . 4. When this man of God had passed the 13th year of his pontificate, one day of Easter when he wished to visit his brethren in the forest of Sescy, he fell sick. But in like manner S. Scubilio fell sick in the monastery of Mandan. Then the messengers meeting him advise the blessed Scubilio to undertake the journey, that he might meet his brother. But an arm of the sea † being interposed, he was not able to ford it at night. But when there was about three miles of space between the two saints, they both died in the same night." And Laut (or Lauto, who was Bishop of Coutances from 525 to 566) ‡ "when he came to visit the place before eight days, brought to the cathedral the blessed Paterne from Sescy, and performed the funeral ceremonies." According to *Neustria Pia*, p. 57, Paterne died April 15, 562, aged 83. And according to Manet, he died in 570. Plees gives at his p. 322 the following, which he extracts from the Roman Catholic breviary, and which corroborates the fact of the former existence of the Forest of Sciscy:—"In the 6th century St. Père, or Paterne, and St. Scubilion came from Poitiers into Neustria (Normandy), and established themselves in the diocese of Coutances; but having desired to pass into a neighbouring island, to live in very great solitude, they were detained by the Christians of Sisci, who besought them to remain amongst them to uproot idolatry. They consented, and founded the monastery of Sisci. Afterwards St. Père having been elected Bishop of Avranches, came at the age of 82 years to visit the said monastery. He died the day before the fête of Easter." §

M. Boudent-Godelinière, Secretary to the Archæological Society of Avranches, in his *Mont S. Michel* p. 19 informs us that "M. Rouault, curé de S. Pair, says in his *Hist. des évêques d'Avranches,* that Saint Leoncien third bishop of this city (elected in 500), often travelled all over the frightful and vast solitude of Scycy, to preach the gospel; and that Saint Gaud died at Scycy in 525, where is now the commune of S. Pair. He had quitted the bishopric of Evreux to live in this retreat, and S. Pair worn out by old age and labours, returned to Avranches from Scycy to die with his brethren about 540; and that under S. Romphaire sixth bishop of Coutances (in 566) S. Sénier, anchorite in the desert of Scycy, afterwards bishop of Avranches, having come to this ancient solitude to visit his brethren, fell sick and died. One could add to this list the name of many other historians." And his own conclusion is, that it is evident that formerly the Bay of Mont S. Michel was covered with forest which extended to a greater or less distance.

76. M. Ogée, geographical engineer of Bretagne, says in his *Dictionnaire Historique et Geographique de la Province de Bretagne*, 1778; that the best known cenobites who have inhabited the Forest of Sciscy are Saints Brieuc, Sampson, Sulia, Magloire, Budock, Broladre, Hildent, Colomban, Meloir, Pol-de-Leon, Tugdwal, Corentin, Malo, Aaron, Goad, Aroaste; and it is from the residence of these anchorites that many parishes of these districts have taken their names. Manet repeats some of these names, and gives a few others in addition at p. 56 with some particulars, viz., "M. Rouault, in his *Abrégé de la vie des Evêques de Coutances*, p. 51, says 'that the deserts of Sciscy and Nanteuil,|| situated at the two extremities of the Cotentin, have produced so great a number of anchorite saints that one might make an entire legend of their lives.' But the most celebrated of which the *Hist. ecclesiastique de Normandie* (Trigan, t. 1, p. 78, 128, 131, &c.) makes mention are (omitting Paterne already named), Saint Gaud bishop of Evreux, and S. Aroaste priest, who both died in Sciscy forest about the year 491; Saint Senier or Senateur, also bishop of Avranches, who died on the 6th or, according to others, on the 18th or 26th Sept. 570; finally St. Pair or Paterne the younger, native of the Cotentin, who was brought up in his infancy in the monastery of S. Pair the elder, from whence he passed to that of Saint-Pierre-le-Vif near Seus, and was assassinated in the forest of Sergines 12 November, 726 by some robbers whom he wished to convert, '*he lived long enough to be witness of the great catastrophe effected in 709 by the sea in the environs of Chausey.*"

* See voucher H. in M.S. appendix for the original Latin.
† Possibly one of Cæsar's estuaries, to be mentioned hereafter.
‡ Lecanu, *Hist. des Evêques de Coutances*, 1839, pp. 31 and 37.
§ See MS. appendix, p. 609, for the original Latin.
|| Near the sea on the coast of Bessin.

At vol. ii., p. 40, Ogée says:—"The territory of Dol presents irregularities on which we ought to remark. It proves the great physical revolutions of another district of Britanny. Mont St. Michel, Tombelaine, the Isles of Jersey, Guernsey, Chosey, Alderney,* and all the little isles which are on the borders of this coast, formed in times very distant part of the continent. We know that in times less remote from us, *a vast forest extended from the environs of Coutances to the rocks of Cesembre above St. Malo* (a direct distance of 38 English miles). The first epoch at which the sea took possession of this immense extent of coast is unknown to us; but we know that the destruction of the Forest of Sciscy ascends no higher than the year 709. This inundation is the origin of the marshes of Dol, of which the length is eight leagues (about 23 English miles), from E. to W., and the breadth, one or two leagues from N. to S. The industry of men has tried to rescue this plain from the sea, which would invade it again in the absence of the embankments which have been opposed to it. A thousand proofs attest this ancient usurpation of the sea. The marshes of Dol are filled with overturned trees, often hidden by a very small quantity of earth. The trees which are the most common are oaks, which have preserved their form, their bark, and sometimes even their leaves. The long sojourn which they have made in the marsh has very much changed their substance; when they are taken out their wood is black and soft; but when they are exposed to the air they become compact, acquire a great specific gravity and an extreme hardness. The more motion of flow and ebb often uncover these trees in the sandy shore." A prodigious quantity of insects and plants of all species, he says, died and rotted in the marshes.

"Another plain, named La Bruyère, situated between Dol and Chateauneuf,† which the sea has covered and which it has abandoned, made equally part of the Forest of Sciscy. The inhabitants of the neighbourhood have dug up for almost eight hundred years, and have not yet ceased to draw out trees well preserved. The excavations made present constantly leaves and fruits of trees of a forest,—acorns, beech-mast, hazel-nuts, stones of cherries. The barks of trees are so well preserved that one recognises, without difficulty their species. The shells of the land and sea are almost everywhere mingled with the earth. In the middle of this plain there is an extensive pool, called the pool of St. Coulman, or Colomban.

77. Manet says, p. 9, that there is a rock called l'Evêque, in the middle of the Bay of Guesclin [west of Cancalle Point] which can only be walked on at low water of spring tides, but which was formerly a strong place. Possibly the little port of Winiau was situated there, or near the ancient canal of Guyoul. It is certain that all the old writings up to 1032, when it ceases to be mentioned, agree in saying that this port was not far from Cancavan, which is our modern Cancalle. The shoals of Petit Pointu and the environs of the Isle Chevret, and the Isles Conchées, Cesembre, Harbour, and Laubras, were well peopled. They are now mere islets, great parts of them having sunk, and are, perhaps, with the single exception of Cesembre, which contains very few inhabitants, entirely unpeopled.

These small islands are north and north-east of S. Malo, between the present coast and the coast line of 709. Other small, and now uninhabited islands, are in the coast line of 709, between Cesembre and Cape Frehel.

78. In *Neustria Pia*, p. 371, is given a most remarkable account of Mont S. Michel, date 709. It says, "This *rock* anciently was a *mountain*," (Hæc rupes antiquitus Mons erat, are the words) "surrounded with woods and forests, extended to six miles in length by four in breadth, on one side contiguous to the main land, on the other to the ocean sea, distant from the city of Arboretana four leagues, on the confines of Normandy and Armorican Britanny. It was called the Mountain in the Storm of the Sea, or the Mountain in the Tomb, at whose foot some hermits had fixed their habitations." On this mountain, he says, S. Ausbert, bishop of Avranches, built a church dedicated to the Archangel Michael, in 709. This bishop at the same time, sent three messengers to Naples to obtain certain relics. Neustria Pia then says, p. 372:—"Whilst, therefore, the said messengers, in performing their journey spent a year, God permitting, the sea surmounted and prostrated the wood, though very large; and filled up with sand the

* It will be shown hereafter that the northern Channel Islands were islands at the time of Cæsar and Diodorus.
† On the N.W. of Dol.

places adjacent to Mont Tombelène. But the messengers having returned on the 16th October, they wondered so much to see the woods replaced by sand, that they thought they had entered into a new world." *

Du Moustier gives the following references in his margin:—"Glaber, lib. 3, Histor. cap. 3.—Sigibertus in Chronic Ann. 709.—Petrus de Natalib. lib. 9. Catalog. Sanctor. cap. 71.—S. Antoninus 3 part. Histor. Titul. 13 cap. 6. § 30.—Constantiense Breviarium MS. Bajocense Vvernerus in Fasciculo temporum ad ann, 704.—Nicolaus Aegidius, in Annal. Franc. sub Childeberto I. ann. 544.

The ancient author Nennius also mentions the top of Mont St. Michel under the name "verticem Montis Jovis" in capital letters, as if it was a mountain of importance.

We see, then, that in 709, the Mont † was six miles long, by four broad. It is now, according to Dr. Hairby's plan, which has every appearance of being correct (scale, five chains to an inch), nearly a circle, averaging no more than 354yds. diameter (equal to 1,112yds in circumference, and 20½ acres horizontal area). What has become of the rest?

79. In the *Acts of the Saints*, which Watts in his *Bibliographical Dictionary*, says "is a valuable compilation of ancient monuments, which throws much light upon the most obscure part of Ecclesiastical History"; we read as follows, in the M.S.S. of an anonymous writer before the 10th century:—"Year of Christ 708, Oct. 16, Seculum III, part 1, p. 86. Concerning the situation of the place; at first, as we can know from truthful writers, it was enclosed by a very thick wood, far from the ocean (the Chesnian codex has it 'distant as it is estimated eight miles from the Ocean') and distant six miles from the tide, affording profound hiding places for wild beasts. * * The sea which was a long way off, rising little by little, prostrated all the magnitude of the wood by its force, and heaped together all things into the resemblance of its sand, affording a means to the people of the earth, that they might relate the wonderful things of God." In the same work it is said, under the same date:—"Concerning the arrival of the reliques. In the meantime the chief messengers returning after a long journey, to the place from which they had set out, on the very day on which the building was completed, in the western parts of the Mont now mentioned; as if they had entered into a new world, which they had left at first *filled with a thicket of briars*."‡

80. The forest of Sessy is often mentioned in the *Acts of the Saints* and *in Neustria Pia*.

81. In Abbé Desroches' *Hist. du Mont S, Michel*, p. 72, he quotes three several M.S.S. of the Mont, all of an earlier date than the 10th century; namely, Nos. 24, 34, and 80, each stating that the sea was six miles distant from the Mont: "Milibus distans sex." The Mont is now about 4½ miles from extreme low water; eastward, it is now 3 miles from the Mont to the general line of coast.

The *Chronicle of Sigibert* the monk of Gemblours which embraces the period from A.D. 318 to 1113, gives an account of the building of the church of Mont S. Michel in 709, by Aubert, bishop of Avranches, in honour of Saint Michael.

82. In fact, say the *Memoirs of the Celtic Academy*,|| "the actual sands of Mont S. Michel were a portion of the continent covered with wood. The river Couësnon traversed this great forest, which was equally watered by the Ardée and the Sée, which overflowed into the marsh."

83. Manet says (p. 96) that a constitution of Louis le Débonnaire, date 817, in which that king, speaking of the convents of his kingdom, which owed to his army gifts of money without men, puts at the head of the list:—"Monasterium sancti Michaelis marisci primi," that is, "the monastery of S. Michael of the first marsh." As if there was then some of the marsh remaining, or otherwise, as if there were more marshes than one. And Lecanu, in his Histoire aforesaid (p. 22), speaking of "Monasterium marisii primi," says in a foot note:—"This Charter is the gift of the Abbey of Mont S. Michel, of a monastery situated very near the Mont, and called the 'monastery-of-the-first-Marsh' (in latere montis) on the side of the mountain." And on p. 21 he says, "in the environs of Granville, the sand on the shore of the ocean bears still the name of the marsh."

Thus we have had abundance of proof that there was an extensive forest surrounding Mont S. Michel, and called the forest of Sciscy, which is now sea.

84. The late Admiral White personally informed the present writer, that in the performance of his duty of taking soundings, on a rock called Le Banc Parisien (at six miles west-south-west of Cape Lihou or Granville Point), the highest part of which is only eight feet below low water; he brought up with the sounding lead, pieces of the thin lead used for glazing windows, with fragments of glass in it. And he saw stones which he thought might have formed a part of a building.—Now the testimonies quoted heretofore, and to be quoted hereafter, and the reasonings thereon, have not had, and will not have, as any part of their object, to bolster up either this, that, or the other theory. The writer cares for nothing but the truth, and that he will diligently seek for, totally regardless where that search may land him. He has suppressed nothing, and will suppress nothing, which appears relevant and worth recording. And, accordingly, he very willingly lays before the reader, the following objections to Admiral White's statement. One of the writer's friends says, "to be candid, I still give very little credence to the glass and thin lead having belonged to a submerged *abbey* or *church*.* If really drawn up with the lead, they more probably were aboard a vessel which was wrecked or foundered in the neighbourhood. But the story is possible." Now on the other hand, glazed leaden widows are very unlikely things to be aboard of any ship, either as cargo or for use. Such windows are usually, perhaps always have been, prepared on the spot or in the neighbourhood, and consequently would not be likely to have been carried by sea. Another friend says, "the lead may have been drifted to the top of the rock by the action of the sea in storms." This is impossible, lead being eleven times, and glass three times, as heavy as sea water. On one side of the rock the minimum depth of water is 36ft., on the other 60ft. Even if storms could affect the sea bottom in those places at those depths, which is very improbable; their effect would rather be to bury the glass and lead amongst the sand and brown shells which form the bottom. The following objection has been suggested by a third friend, who is a naval officer. He knew a case where a piece of sheet lead was affixed to the bottom of a ship below the water line, and after the ship had sailed for some time, it was found that the lead had entirely disappeared, having been corroded away by the action of the constituents of salt water, as he thinks. May not the friction of the water against the lead, whilst the ship was sailing, have worn away the lead? If so, Admiral White's lead *being stationary*, might possibly have existed under water since 709. The question is submitted to chemists and other experts, whether or not the lead would have existed as described for 11½ centuries? At the same time it ought to be borne in mind, that even if it should be a general opinion that the lead could not have existed so long, that circumstance would only invalidate one, out of scores of testimonies.

85. Admiral White also stated, that on one occasion when he was afloat, near Fort Rimains (south of Cancalle Point), the weather being calm and the water very clear, he saw at the bottom "divisions," which he took to have once been garden fences. To this the friend first named in the preceding article, objects as follows:—"I hold that the garden fences or trenches *must* have disappeared with the action of the sea, in the course of a thousand years, even although sheltered by the promontory of Cancalle. If a trench were dug in St. Aubin's Bay, I am sure it would fill up in the course of a winter." To this the present writer answered, under date June 30th, 1860. "I entirely agree with you that if a trench were dug on St. Aubin's sands it would very soon fill up, because those sands are laid bare at low water, and exposed to very violent action of the waves in storms. But at 15ft. or more below extreme low water, where the "divisions" not "trenches" were seen, and where they are so well protected by Cancalle Point, is the very perfection of tranquility, because at equal depths the pressure of water is exactly equal in all directions." A cubic foot of sea

* The original Latin is quoted in the M.S. Appendix.
† Mont S. Michel.
‡ The original Latin is in the M.S. Appendix.
|| Tom. iv., p. 384, 8vo. Paris, 1809.

* Neither the Admiral nor the writer said anything about the *nature of the building*, the former mentioned church windows, only to show that the lead was glazing lead.

water weighs 64¼lbs., which gives a pressure of 964lbs. per square foot, at 15ft. average depth; which being applied to the divisions *equally in all directions*, is a pretty good guarantee for their stability. The gentleman then quoted the low district theory, disposed of in Art. 11. And when the objections referred to in opposition to that theory, were stated to him, his reply was, that he was not a scientific man. Not long after, a paper to the like effect, showing that the low district theory is an impossibility, was sent by post by the present writer to the author of that theory, And an offer was made at the same time, either to consider his answer confidential, or to print it side by side with the reasoning against it. But up to the present moment, Sep. 15th, 1866, no answer has been received from the author of the theory.

D'Argentre, the Historian of Britanny.

86. We learn as follows from *Morery's Historical Dictionary*, Amsterdam, 1702:—"Messire Bertrand D'Argentre, lieutenant-general or grand seneschal of Rennes, was one of the most illustrious ornaments of his family, which was one of the most noble and considerable of this province. He was learned, magnificent, honourable, liberal, and the most generous friend in the world. He composed learned Commentaries on the Customs of Britanny, which the most skilful, and amongst others the famous Charles du Moulin have given their great praise. We have also of his a History of Britanny, which he undertook at the instance of the states of the province. He died 13 February, 1590, aged 71." This eminent man, in describing the course of the river Couësnon as the boundary between Normandy and Britanny, uses the following remarkable expressions, namely, that at the time he refers to, the river meeting the reflux of the sea, "is constrained to yield to the strongest, and flowing over the land which it finds *below* it, is so spread out that it has submerged one or two leagues of the best country of Britanny." And he says, farther, that the sea "every morning increases," so much so that on one particular morning "it ruined more than four leagues of very good land, and more than 100,000 livres of proprietors' revenue,"* namely, of the annual value of £7,500 sterling. The writer's belief is, that the ground was *quietly* settling down day by day, and nobody suspected it. How could the sea have overwhelmed it then, and never before on any other hypothesis?

87. A large collection of accounts of earthquakes has been made for the purposes of this work, embracing all that could be found, for the period between the third and seventeenth centuries. All that are at all connected with the northerly and westerly coasts of France are stated in the MS. Appendix. It does not appear that any of the sinkings can be identified as the effects of earthquakes. We ought not to be surprised at these occurrences passing almost, and sometimes altogether, unnoticed, because they happened mostly before geology had become a science, and consequently before such events were understood. The inhabitants could only observe that, whereas yesterday the given tract was land, to-day it was sea. Sir Charles Lyell † describes the sinking of a tract of land, called the Runn of Cutch, at the mouth of the Indus, 2,000 square miles in area; it sunk in a few hours. And he quotes Sir A. Burnes as stating that "these wonderful events passed unheeded by the inhabitants of Cutch;" for the region convulsed though once fertile, had for a long period been reduced by want of irrigation, so that the natives were indifferent as to its fate. A similar indifference appears to have occurred on the coasts of France, almost with the single exception of records kept in monasteries—all honour to the monks for their care and thoughtfulness,—there appears to be no record at all of the sinkings about Guernsey farther than that the submarine gorban or peat was first discovered about 1750, being the first record of the event.‡ Is it not probable that other catastrophes of the same nature may have taken place in the localities in question, without having been noticed, at least without being recorded at the time they occurred?

88. Manet relates (p. 102, 103) an entertaining anecdote quoted from the author of the *Observations on the desert of Scisey*, who gives the date 1685. A priest of the diocese of Dol being aware of the tradition that in a place now occupied by the sea there was formerly a parish called St. Louis, mischievously sent word to Rome, that the cure was vacant by death and was in the gift of the Pope. On receipt of this news, the registers were consulted, and it was found to be perfectly clear that this parish had been presented to by previous Popes. It was put to competition and fell to a priest of Lower Britanny, who went immediately to take possession. But what was his surprise when he arrived in front of Mont S. Michel, and the place was shown him *amongst the sands*, where the pretended parish was formerly situate. His only course was to make attestation of the state of the case and return it to Rome, and then seek another benefice."

* D'Argentre, *Hist. Bret.*, 1611, folio 41 F, &c., quoted in MS. appendix.
† *Principles of Geology*, 1853, p. 461.
‡ *Annals of the British Norman Isles*, by John Jacobs, Esq. 1830.

89. *Testimony of S. Pair, the poet.* The following is from Dr. Hairby's *History of Mont S. Michel.* Guillaume de S. Pair, a monk of Mont S. Michel, wrote in verse in the 12th century a history of the Abbey, &c., from which it appears that the Mont had once been surrounded by a celebrated forest which he calls "Quokelunde," [perhaps *Coquillunde*, land of shells, according to Abbé Desroches] where there was once abundance of venison, but where there is now nothing but fish. And that it was an easy walk from Avranches to Poelet and to the city of Ridolet, which last according to M. Edouard le Héricher is probably the very ancient city of Aleth, bordering the river Rance, on the west of S. Servan. Camden and D'Argentre call it "Quidalet."* Manet says it has also been called "Wic-Aleth," and that it was surrounded by walls as early as 250 B. C, It has also been called "Guich-Alet." M. de la Rue says he believes the historical details of the poet, for he wrote under the eye of his abbot Robert de Thorigney, a learned annalist who could not easily be deceived; and that the MS. was taken to England during the French resolution. Robert de Thorigney, otherwise called Robert du Mont, was the 15th Abbot of Mont S. Michel, from 1154 to 1186.† Here is an extract from the poem:—

"Desous Avranchos vers Bretaine
Qui tous tems fut terre grifaine,
Est la forêt de Quokelunde
Dunt grant parolo est par la munde;
"Ceu qui or est mer et areine,
En icels tems est forest pleiue
De mainte riche venaison
Mes ores il noet, li poissou
Dune peast l'en très bien aler
Ni estu cst ja crendre la mer
D'Avranches droit à Poelet
A la cité de Ridolet.
En la forest avait un Mout, &c.
* * * *
Uns jouvencels, moine est del Mont,
Dous en son règne part li dunt,
Guilleline a nom de St. Paier
Escrit en cest quaier,
El tems Robeirt de Thorignié
Fut c'est romans fait et trové," &c.

90. From *Mont S. Michel*, par M. Boudent-Godelinière, 1845, p. 14, we learn as follows:—"The poet, M. Chateaubriand adds, fixed the irruption of the sea in the reign of Childebert," which was from 511 to 558, according to Morery's Dictionary. M. Boudent-Godelinière who was secretary to the Archæological Society of Avranches, also says, after quoting S. Pair's verses aforesaid, at p. 16:—"To these probabilities, in favour of the existence of a forest in the Bay of Mont S. Michel, one may add all the great number of trees which it is certain have been found, all blackened, buried nearly everywhere, not only on our sandy shores, but *also under the waters in the part of la Manche, situated between Agon and Jersey.*

Note.—Agon is a village near the coast of Normandy, west of Coutances, Manet's coast line (shown on the map), at the beginning of the year 709, is not a little surprising by the great extent of sinkings which it indicates.

* Camden's *Britannia* p. 1512, edition 1722.—D'Argentre's *Hist. Bret.*, 1611, folio 113.
† *Hist. de l'Avranchin*, par M. Edouard le Héricher, Vol. 2 p. 230.

[illegible] for a ship on Lloyd's list, should be influenced by the

† *Hist. de l'Avranchin*, par M. Edouard le Hericher, Vol. 2 p. 230.

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‡ *Annals of the British Norman Isles*, by John Jacobs, Esq. 1830.

† *Hist. de l'Avranchin*, par M. Edouard le Hericher, Vol. 2 p. 250.

But Ptolemy will soon convince us that those are but a small fraction of the sinkings which have really taken place during the last seventeen centuries.

DOUBLE PISTON-ROD EXPANSIVE AND SURFACE-CONDENSING MARINE ENGINES, 350 H.P.

By Messrs. J. and G. Rennie.

(*Illustrated by Plate* 305.)

The accompanying plate illustrates the engines which have recently been constructed upon the double piston-rod expansive and surface-condensing system, by Messrs. I. and G. Rennie, for the Peninsular and Oriental Steam Navigation Company, and fitted on board the Egyptian steamers *Charkieh* and *Dakahlieh*. The following are the particulars of the engines, &c.:—Horse-power, nominal, 350; horse-power, indicated, 1,900; draft forward, 15ft. 6in.; draft aft, 18ft.; mean draft, 16ft. 9in.; weights on board, 815 tons; diameter of cylinders, 63¾in.; length of stroke, 3ft.; revolutions, 75; mean speed, 14·119 knots; screw, six-bladed; displacement, 2,200 tons; area, 484; co-efficient midship section, two-thirds, 717; co-efficient displacement, two-thirds, 252; mean of both, 969.

At the trial which took place under the superintendence of Mr. Lamb, engineer-in-chief to the Peninsular and Oriental Company, at the Stoke's Bay Government measured mile, near Southampton, the *Dakalieh* proved herself to be one of the fastest vessels of her class, her mean speed being over 14 knots. The boilers and super-heater are on Lamb's patent flue principle. The engines have cylinders of unusually large size for the purpose of working the steam expansively, for which there are special gearing and valves applied. The *Dakahlieh* as well as her sister vessel, the *Charkieh*, made several voyages from Alexandria to Constantinople, and have proved themselves to be about the fastest and most economical vessels on the line; the consumption of coal being a little over 2lbs. per horse-power.

The condenser is fitted with copper tubes, placed vertically; the steam being condensed inside, and the cold water circulating outside. The packing through the tube-plate is made of cotton, and tightened by means of a saw-gland. Both the circulating pump and the air-pump are worked direct from the piston.

In our plate, fig. 1 is a sectional elevation of engines, &c.; fig. 2, a plan; fig. 3, an end view and cross section of cylinders; and fig. 4, an end view and cross section of condenser.

SHIPS, COMMERCIAL AND WAR,

By William Eathorne Gill.

It is generally admitted, that the arts and sciences have progressed among us, although some of the most useful, were somewhat stunted in their growth, by cold indifference, or nipt by the bitter frost of private opposition. The opportunities for commendation of shipbuilding, occur as by accident, and that but too seldom for maintaining the superiority to which we have been prone to lay claim. We have been at peace, and at ease. Modern legislation has augmented our confidence, and men have traded on that confidence. The advent of ships, and steam vessels, pleases the eye; and superficial observers chronicle the fact in such euphonious language, as interest, or new paint and varnish can suggest. The miserable "list of the lost" is left to its daily accumulation, as if it were a mere record of events beyond our controul. Its "sum total" is too frequently blurred, by the names of those who have been untimely plunged into eternity. It does not necessarily follow that we are degenerated, because good ships are the exceptions, and not the rule. It is possible, that the capability for better things, in relation to ships, which once obtained among us, has been superseded, or absorbed, or thrust aside by an overweening cupidity. The idea of buying in the cheapest, and selling in the dearest market, is here strictly carried out into practice. But we do not find scientific men, nor skilled artizans, shining as hucksterers, and therefore the latter hold the former cheaply. We may thus get a clue to their relative positions in shipbuilding.

The history of the system which obtains, is simply this. A shipowner is beset by competitors for his favours. The cheapest—your "hardest nail," is invariably the cheapest—offer to build his ship, is accepted. The ship is built and launched. The legislature has provided officers for navigating the ship, and prescribes the number of the crew. Commerce affords a freight; the government dictates the quantity, and quality of the stores. The owner's interests are fenced around with the *lex scripta*. His scientific attainments, or preferences—assumed or real—like his generosity, may not be imposed upon, seeing they are not invited, and passengers aver that the latter is never intruded. After all, this may not be matter for regret, when caprice might indulge in error which is avoided. The owner is content with a glib promise of excellence. The ship and her history may be told in a breath; she is built, and launched, and sailed, and lost.

The ship was, of course, the owner's, but not the loss. That loss was the underwriter's. The owner is reimbursed; and as promptly purchases another ship, which, by some accident escapes storms, and other dangers of the sea, and returns safe into port. The game is not *rouge et noir*, it may be only *red tapery* reduced to system.

If we pass on to the person who contracts to build the ship, we may find him absorbed in the economy of construction, directly or indirectly, himself or his assistants.

His great aim is to "get the job," and next to enter into sub-contracts that can leave him "a comfortable margin. He must recognise "Lloyd's rules," and he does so by rule, by rule only. It would be inconvenient to comply in a generous spirit of excellence, it might be more expensive and annihilate his profit. Therefore, he does not consult experience beyond these rules, and experience and excellence are alike neglected, thrust aside out of his way. Lloyd's rules prescribe dimensions, and compliance ensures the necessary qualification for insurance, and all is made pleasant.

That we may not fall into error, we can turn to an advertisement in one of the professional papers for 20th July, 1866, "Wanted, a man to take the work by the piece, or ton, for a small shipyard, where locomotive, marine, and other boilers are made; he must be thoroughly competent to construct vessels from drawings, and models, and to lay them down. He would require some capital, as payment would only be made as the work progressed, and a guarantee would be required for the work being finished in a first-class style. Apply, &c." The advertiser appears to be disposed to accept an assurance for competency to construct, but he requires a guarantee for the work being "finished in a first-class style." In a word, we look again, and in vain, for any clue to the dignity of excellence. We may have, instead, the sweepings of a milliner's shop, "in a first-class style," the worse for wear. It is quite possible for this slip shod slang to have a far different signification in the North, to what it has in the South of England.

Without carrying our analysis further, we can perceive the position in which naval architecture is practically placed, by shipbuilders, and by shipowners.

Neglect engenders loss; and who suffers the major loss here? who else than the underwriters, if the crew are saved. Therefore it must be in the interest of the underwriters to promote the study and application of naval architecture. Whilst it must be admitted that they have done much, so also it is contended that much remains for them to do, and that for their own benefit. To apply their dimensions involves the whole question; to apply them in a spirit of parsimony, or generosity, can involve *all the difference between a good and a bad ship*. Therefore, the ship whilst building, should be under the eye of experience, and that experience should be in the interest of efficiency, that is, in the interest of the underwriters. It is idle to look for it where it is not their interest to afford it. We may thus secure an efficient control and progressive improvement in our mercancantile navy.

The position for a ship on Lloyd's list, should be influenced by the

record of "daily progress" kept by the surveyor, whilst the ship is being built, to be confirmed or modified by a survey of two or more officers, in some ultimate stage of the work. These expenses could be covered by a charge on certificate of class, which certificate might also influence the contract of the builder with the owner who pays the minimum rate of insurance on the highest class ship, and therefore in a better position to reimburse the builder for the best design and workmanship.

Of course I would retain whatever is to be found in the present mode that can be consistent with, a stricter qualification for the highest class of ships, and the minimum rate of insurance. It occurs to me, that it remains with the underwriters to enforce this prudent strictness, in their own interest. They must engage professional talent, for no captain can help them.

We see this daily exemplified in the navy, where the notions of admirals, too often weigh down against professional experience. The naval officer has been in the habit of enforcing obedience on his quarter-deck, and necessarily so, but neither wood nor iron can be subject to other than their own laws, and stubbornly resist the inconsistent command of the finest admiral that ever faced a foe. It is the study of the professional man, rather than of the admiral, to be familiar with those laws, to which the elements of his structure are obedient, as also those other laws, to which his structure in its completeness must submit. When your admiral orders such things in a contrary direction, he deceives himself if he believes he has brought all these several laws into subjection to his will. Compliance is enforced, and the immutable laws remain, antagonistic to success.

Most of us are familiar with the name of Captain Cooper Coles of turret notoriety. Political partizans found it a convenient *cheval de batail.* The captain had a notion about a turret, and he had as accurate an acquaintance with the value of those elements essential to the practical use of his notion. His advocates now profess to have discovered that "the Captain is not a mechanic," and endeavour to back out of responsibility with that lame, apologetic sneer.

The caprice of the Emperor of the French, of fighting-ships in armour, has cost this country many millions of pounds sterling. That astute sovereign saw the necessity for protecting his sailors with iron. English seamen know how to take care of themselves, in the presence of an enemy. But we could not permit an enemy to enjoy such an immense advantage as mechanical invulnerability, without placing our sailors on equal terms. To bring this about in the best manner, has involved an immense outlay of money, and of time for making elaborate and heavy experiments. Now that we are beginning to see our way through the new order of things, which this French notion involved, the attention of France itself is diverted from her expensive toy, from the water to the land, where a neighbour has become formidable on her border, by assimilating a host of kinglets distinguished by insignificance, and Anglophobia has passed into Prussophobia. Whilst surrounded by insignificance owing to divided allegiance, France could afford to be indifferent with magnamity, and concentrate her efforts on excelling England in some enviable particular—the navy. Her excellent attentions are now happily diverted; her Emperor is "in check," and some of his sagacious designs are frustrated. It did not comport with her dignity to act on the suggestion of England to save unoffending Denmark, and France has now another sort of neighbour, sturdy enough to look her full in the face, as a consequence; one who divides her anxieties with the new murderous toy, *the chassepot musket.* We may now carry out our naval armaments at leisure; and improve our mercantile marine at the dictates of humanity, if not in the interest of commercial integrity. Underwriters should consult their own interests, and ensure improvement in naval architecture, by heavily taxing dishonourable ignorance. It is in their power and their interest to do so. "The wave theory" has had its day—an ephemeral one—as it deserved. It is high time to inaugurate another, a better system, that shall redound to our credit, in theory and in practice. It were difficult to find a better opportunity to set about the task than the present. If it be worth our while to build ships, it becomes us to build good ones; whilst the long list of the lost, is an eternal disgrace to all concerned.

I conclude, by repeating "to apply the dimensions prescribed by the underwriters, involves the whole question; to apply them in a spirit of parsimony, or of generosity, can involve all the difference between a bad and a good ship. Therefore, the ship whilst building, should be under the eye of experience, in the interest of efficiency." If the contractors for building ships are not disposed to incur this expense directly, they can be compelled to do so indirectly, through the medium of the underwriters who are so highly interested in the practical difference between a good and a bad ship.

Since writing the foregoing I have had a Liverpool paper of the 20th September (the *Daily Post*) put into my hands, in which I find this subject ably ventilated, from the purely nautical point of view, and headed, "A voice from the dead." Its first paragraph commands attention. "Two thousand persons lose their lives every year by shipwreck, off the British coast. The fact is a disgrace to the nation, and steps ought to be immediately taken to investigate the circumstances under which such a grievous loss of human life takes place." If to these "two thousand" lives lost at home, we add the thousands that are lost abroad, our humanity is challenged by such a total, and sordid indifference must give place to some nobler feeling. Again we see the underwriters are appealed to, and some correspondence has been going on on the subject. Thus, we read, "An underwriter at Lloyd's, writing to Mr. Larcon remarks, "I *wish* you could persuade shipowners to find, and man their ships properly, and that would, in some measure, at least, diminish the great loss of life that annually takes place, and also the transfer of much money out of our pockets." I apprehend that this is but another evidence of the improper facilities afforded, for ships standing A 1 at Lloyd's. The committee of Lloyd's can make these rules of theirs more stringent, on all the points mooted. Self interest, if no higher motive, should suggest the necessity to do so. It is quite possible for self interest to suggest, that the approach to completeness of a ship, reduces the necessity for insurance, if it does not invite among the reckless, a positive indifference to that prudential course. This view of the case might be met, by a corresponding reduction of the premium to be paid by the owner. For, the risk on a honestly-built ship, when properly found, manned, and officered, is certainly reduced to the minimum, and that minimum may not be delayed, or, where is our honesty, or that of the underwriters.

STEAM BOILER INSPECTION ON THE CONTINENT.

In most countries of continental Europe laws have been enacted, and government decrees issued from time to time, for the purpose of protecting life and property from the dangers incidental to the use of steam generators. Thus, in France, a government license is required for erecting a steam boiler in any inhabited place, and its grant is made dependent on the result of the so-called *enquête de commodo et incommodo, i.e.*, a preliminary enquiry by the local authority, in which every opposition on the part of local interestees, unless overruled as vexatious or unfounded, will prove fatal. There are, moreover, official formulæ for the relative thickness of boiler plates and pressures of steam, and a government stamp is affixed to every boiler stating the utmost pressure, in atmospheres, to which it may be subjected. To ensure the strict carrying out of the rules and regulations, a government inspector (mostly of the corps of ingénieurs des mines) is appointed, who pays, from time to time, unexpected visits to the boilers of his district, and heavy fines are enforced wherever safety-valves are overloaded, or the proper precautions overlooked. Similar regulations are in force in the German States, in Belgium, and most other countries of the Continent; the supervision is entrusted to the "building inspectors" in Prussia, to mining engineers in Belgium. The strict control exercised by the various governments over all steam generators, both those actually in use in the respective country, and those intended for exportation, forms a kind of moral pressure on manufacturers and users,

and has for its effect that the number of boiler explosions in Continental Europe is proportionally not one-tenth of those in Great Britain, and less than one-twentieth of those in the United States. However, it has been remarked that most of the government officials whose duty it is to exercise an efficient control, are not properly qualified for the discharge of this duty, as mining and building engineers are not generally possessed of a sufficient knowledge of practical *mechanical* engineering, and the construction and management of steam generators; and although the general result arrived at by an inefficient system of government inspection has hitherto, throughout the Continent, been far preferable to the system of *laisser faire* in the United Kingdom, a movement has just commenced in some parts of Germany, tending to substitute an efficient private inspection for the insufficient government supervision. To this effect a society has lately been established in the Grand Duchy of Baden, and a recent number of the *Frankfurter Journal* gives the following account of its *début* :—

The "Association for the prevention of Steam Boiler Explosions," lately established in the Grand Duchy of Baden, is worthy of the attention of the whole industrial public of Germany. To our knowledge this is the first experiment made on the Continent with a view to attain, by independent means, an important object of private interest and general utility, and thus rendering superfluous any further control on the part of the authorities. In most states, steam boilers are inspected officially by public functionaries, who are but very seldom possessed of any special practical knowledge of the manufacturing and working of steam generators. In nine cases out of ten, the inspection is either made externally and superficially only, or more thoroughly and circumstantially than the nature of the case would require. The English who have done great things, both in engineering and in self-government, have, through the Manchester Association, extended over their whole country, the means of preventing boiler explosions, and thus protecting private interests, without the least interference on the part of the government. This example has been acted up to in Baden. The association causes the boilers of its members to be inspected by an engineer, theoretically and practically well acquainted with the construction and working of steam generator and engines. The boilers are thoroughly examined at least twice every year, both externally and internally. Besides, a mutual insurance takes place amongst the members, and thus they obtain the best means of safety, both for themselves and the public at large. These are valuable commencements of self-government on practical ground, which ought to be tried everywhere, and fostered as much as possible. The annual report of the Offenbach Chamber of Commerce gives due praise to the efforts of the Baden society; it is to be hoped that the sixty odd proprietors of boilers in Offenbach will be moved to consider the expediency of joining that association. This would be a step in the right direction.

The reporter of the German journal is mistaken in two points, respecting England. In the first place, there certainly exists a kind of Government supervision on steam boilers, but it is entirely confined to those on sea, which are not allowed to work unless previously inspected by an official well fitted for the discharge of this duty. The safety of life and property on *terra firma* is indeed committed to the tender mercies of makers and workers of steam generators; Government but very seldom extends its control over the latter, and then also it confines itself to post mortem examinations (both of boilers and human beings) in such cases of accident as may have involved an *unusual* loss of life and destruction of property. Secondly, as regards the Manchester Association for Prevention of Steam Boiler Explosions, its sphere of action is not by far so extensive as the reporter assumes; it is restricted to Manchester itself and the surrounding manufacturing districts of Lancashire, Cheshire, &c. To the best of our knowledge the number of boilers under their inspection is not one-fourth of those actually at work in those countries, whilst the rival "insurance company" cannot even boast of the same patronage, and thus upwards of one-half of the steam boilers in the most important manufacturing districts are left entirely destitute of inspection. Throughout the remainder of England as well as in Scotland, steam generators are exclusively entrusted to the skill, discretion, and sobriety of the attendants, and its speaks highly in favour of the latter as a class that in this country no more than about half-a-dozen *disastrous* explosions should happen every month. In the United States the proportion is much larger. Endeavours to imitate the example of the Manchester Association in other parts of England have hitherto been frustrated by the sluggish apathy and want of *entrain* on the part of proprietors of boilers. Thus, the one established in London some years back did not enjoy an existence of more than about twelve months; we believe a similar attempt in Leeds proved equally fruitless. The system of Government inspection and general interference of the authorities, as practised on the Continent, may have its drawbacks, but there is no doubt that it is nevertheless far preferable to utter want of control, as prevailing in this country. Yet, a system of private, self-supporting supervision offers many advantages which have been very correctly pointed out by the reporter. On the whole we are of opinion that some action on the part of the Legislature has become not only a *desideratum*, but an urgent necessity in this country. In the province of the Manchester Association, the owners of steam boilers have at present the option between inspection or non-inspection; in other parts they are even deprived of the first alternative. In future, the option should be between Government and associate supervision, and most of the interestees will doubtless give the preference to the latter, and thus facilitate the establishment of societies for the prevention of boiler explosions in other parts besides Lancashire. An efficient control is not only "devoutly to be wished for," but must, in one shape or another, be forced on the recalcitrant parties. Self-government and self-control are very well in their way, but to leave them an unlimited scope is altogether out of place, where the life and property of thousands is liable to be seriously jeopardised, even destroyed by the indiscretion of a single individual.

BOILER EXPLOSION.

The Scottish newspapers give a circumstantial account of the explosion of an upright boiler. As this class of boiler recommends itself where space is valuable, it appears highly desirable to accumulate whatever may grow out of its use, for or against it. We therefore present our readers with the following, without further comment:—"A boiler explosion, attended with the most disastrous results to life and property, occurred in the well-known iron works of Messrs. Rigby and Beardmore, situated at Parkhead, Glasgow. These works are perhaps the most extensive of their kind in Scotland, and give employment, in various departments, to between 600 and 700 men. Every species of maleable iron manufacture is carried on, from the forging of the heaviest shafts, &c., employed in marine engineering, down to boiler and shipbuilding plates. Here have been produced those massive slabs of iron used in protecting the batteries of our armour-plated ships; and amongst others, the sides of the Black Prince and the Hector of our own navy, the Rolf Krake of the Danish, and the Turkish frigate which left the Clyde a few months ago, armed with the manufacture of Messrs. Rigby and Beardmore, who, in addition to trade done at home, are in the habit of exporting large quantities of this particular description of plate.

The particular department in which the explosion occurred is that known as the "Forge," which lies on the north side of the works, immediately facing Duke-street, the mills occupying the hollow beyond, and to the southward. In this portion of the works, when in full operation, no fewer than nine ponderous steam hammers are employed night and day. Motive power to these heavy machines is supplied by a series of boilers. The one which burst—for fortunately only one gave way—was used for working a 5-ton hammer, the boiler being located a few yards to the west. It was of rather a singular construction, somewhat resembling a gigantic nautical telescope standing on its broadest end. The main body of the boiler, which may—to continue the figure employed—be taken to represent the outside casing of the telescope, stood 36ft. high, with an external diameter of 5ft. 6in., and was constructed of stout 7-16in. plates. It stood on a circular brick foundation, and was fired from beneath, the smoke and flame ascending through a flue in the interior, of half-inch iron, and 3ft. in diameter. Above the boiler, which penetrated the roof of the sheds containing the machinery, the flue was continued by a funnel, perhaps 20ft. additional in height, giving a total perpendicular, including the brickwork beneath, of more than 60ft. From a slackness experienced lately in the receipt of orders, the works had not been doing much since the holidays, but on Monday this boiler was doing duty, and at six P.M. was placed in charge of a young man named John Tennant, for the night shift. So far as is known, Tennant attended to his work in the usual way, and all went on well until five or ten minutes before seven in the morning, when the boiler exploded with frightful violence, ascending like a rocket straight up into the air for upwards of 300ft., and falling again directly on its bed with a tremendous crash. As the necessary consequence of such a disaster, of course, steam and boiling water were scattered in clouds and showers all around. The force of the explosion blew up portions of the roofs, and otherwise destroyed the sheds in the vicinity, but from the construction of the boiler, and its being simply seated on level brickwork without being in any way surrounded, few or no bricks were sent flying over the work, to injure property and kill or maim the workmen. Still, the damage done to the buildings and machinery, and the loss of life and injury to limb, have been very great. The shed containing the hammer and boiler has been to a great extent wrecked; and the one adjoining, the roof being continuous, has not escaped. A store immediately opposite, on

the Duke-street side, had its front wall driven in, and its roof blown down; while a building adjacent, used as a temporary pay-office, has suffered serious damage.

Meanwhile, the cause of the catastrophe remains a mystery. The Procurators-Fiscal have made a remit to two engineers to examine the boiler, but their report has not yet been given in.

DIFFICULT TRANSIT.

Large masses of manufactured material sometimes give rise to considerable difficulties in their transit from their place of manufacture to their ultimate destination, and we have lately had a case in point in the metropolis.

A large crank shaft for H.M. Steamer *Hercules*, weighing 34 tons 11 cwt. 7 lbs., and supposed to be the largest iron forging ever made, was lately completed at the Mersey Steel and Iron Works, Liverpool. The forging is intended for the main crank shaft of engines of 1,200 nominal or 7,200 indicated horse-power, now being constructed by Messrs. John Penn and Sons, of Greenwich.

When the forging was made it had to wait a considerable time at Liverpool before the London and North Western Railway Company could spare their large trolly to carry it to Camden Town Station. When the trolly was procured, arrangements had to be made for the conveyance by special train, which was only permitted to move at the rate of ten miles per hour and on Sunday, so as not to interfere with the other important traffic of the line. Arriving safely at Camden, its chief difficulties seemed to commence. Messrs. Pickford, the great railway carriers, on making inquiries respecting the best route to take it from Camden to Messrs. Penn's factory at Greenwich, where it had to be delivered, found all sorts of obstacles present themselves. The noble new bridge at Westminster, one of the latest achievements of modern engineering, was closed against them under threats of official pains and penalties; and special care was taken for fear the terrible shaft should be smuggled over the bridge unawares.

Waterloo Bridge came to the rescue, and was pronounced by its owners as sufficiently strong for any weight, and was accordingly selected; but there were several other difficulties to surmount, such as the Underground Railway, two railway bridges at New Cross, where the traffic was suspended for a few minutes whilst the monster crossed, and last, but not least, was the Ravensbourne at Deptford, where an old-fashioned bridge looked rather shaky; but by perseverance these difficulties were surmounted, and the shaft was landed in safety at Messrs. Penn's establishment. The shaft, which with the trolly upon which it was carried, weighed 45 tons, left Camden at six o'clock in the morning, drawn by thirty of Messrs. Pickford's fine horses, and was followed by crowds the whole way.

Going down Regent-street and Waterloo-place, the shaft appeared at times to be in danger of overrunning the horses; in fact, at one part of the latter, the Guards' Monument appeared to be rather in danger from the momentum the shaft had acquired in the steep gradient, but the powerful breaks on the trolly which conveyed it, brought it up in time to round the corner safely.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(*Continued from page* 211.)

SECTION E.—ECONOMIC SCIENCE AND STATISTICS.

Mr. James E. Thorold Rogers, M.A., President of the Section, delivered the opening address, which comprised a very able and interesting exposition of the issues involved in the questions of the coal supply, the recent monetary crisis, and statistical inquiry as affecting agriculture, electoral returns, the prices of labour and food. He said:—Among the various questions of great economical importance which have been before the public during the past year, there are two on which, with your permission, I will make a few brief comments. These are the contingency, at no remote date, of a considerable exhaustion of certain mineral resources in this country, and the altered position which England might consequently assume, and the present condition of what is familiarly called the money market. The first of these questions raises a variety of issues, the magnitude of which cannot be over estimated; the second is a crisis unparalleled for its severity and its duration. It cannot, of course, be denied that a limited quantity of any natural product, the demand for which is incessant, must ultimately be exhausted. But the real question, it seems, is, when will the scarcity price operate on consumption, and when it does so operate in what will the saving be effected? That the scarcity price is not yet operative is manifest from the increase in the aggregate consumption of coal, and from the increased production of metals; for it is in the smelting of metals that the largest consumption occurs. Nor can it be doubted that when the saving becomes necessary from enhanced price the economy will be exercised in this direction. But the total value of all metals produced in this country in the year 1864 (the largest in value, though not the largest in amount, yet recorded) was worth little more than 16 millions, a great but not a dominant quantity in the annual aggregate of British industry. It would seem, then, that the alarm, if it be not premature, is certainly excessive; that there will be abundant warnings of future scarcity, and necessary economies in dealing with the residue, long before that residue verges to exhaustion. The material wealth of this country, it may be observed, greatly as it is related to its manufactures, one of the raw materials of which is locally limited, is far more fully derived from its geographical position, and thereupon its trade, the advantages and aids of which are permanent. Occupying, as Great Britain does, the most central position between the New and the Old World, it is and will be, so long as its people are industrious and resolute, the highway and the mart of nations. Its commerce, by virtue of causes which cannot be reft from it, increases at a far more rapid rate than its manufactures; and if that commerce remain unfettered and unshackled there seems no limit to the width which its markets may attain. It would not become me, in an introductory address, to enter on the vexed question of the currency, and in particular to criticise the Act of 1844. Opinions are, as is well known, broadly and sharply divided on that famous measure. With some thinkers this system is lauded as one of consummate wisdom; with others it is censured as one of needless and mischievous interference with that part of the machinery of trade which would be self-adjusting without it, and which is not really supported by it. As a rule, indeed, when one set of persons, confessedly competent to form a judgment, decide that a law dealing with commerce is wise and useful, and another set of persons equally competent declare that it is foolish and mischievous, it will generally be found, in course of time, that the latter are in the right. Such was the case with the Colonial system, with the Corn Laws, with the Navigatian Laws, with the Sinking Fund, with the laws regulating and prohibiting the exportation of coin, with bounties, with export duties, with the favoured nation clause of commercial treaties. It has been stated, but not I think proved, that the cause of the present crisis has been excessive or over-trading. As far, however, as can yet be discovered, it seems to be due far more to imprudent action on the part of certain banks, who have made advances at long dates, or on securities not readily convertible. The distrust which has followed on the failure of some among these banks had led to the absorption of a large amount of the note currency by the solvent banks, with a view to making their position impregnable. But this retention of notes, as it has limited the amount of accommodation, has indirectly raised the rate of discount, and thus it follows that as long as the rate is high the notes are hoarded, and as long as the notes are hoarded the rate will be high. It is worth the attention of the section to consider whether the contingency of such a dead-lock as the present may not, concurrently with the restrictions of the Act of 1844, or independently of them, be rendered more frequently imminent by the increased inducements in the shape of high rates of interest offered to the public on deposit accounts. At all events, the present state of affairs is without parallel. Once, in 1857, the rate of discount touched 9 per cent., just before the relaxation of the Act. It has stood on the present occasion for some weeks at 10; and unless British commerce is now conducted under far more favourable circumstances than it could have been nine years ago, the effect must ultimately be ruinous to the trader—must be speedily be followed by a great rise in general prices, and, in all probability, by a glut of capital at no distant date. The value of agricultural statistics does not lie simply in the aid which they may afford in indicating the probable course of the market, and in saving it from needless fluctuations, but in suggesting what is the probable annual deficiency in supply. Many years have passed since this country grew enough food for its inhabitante. That its prosperity may be uninterrupted it will be necessary that it should rely increasingly on foreign produce. That its people should be well fed it is necessary that every facility should be given for the growth and importation of live stock and meat. The table of statistics giving information of the amount of cattle, sheep, and pigs, on the 5th of March, 1866, on the presumption that the returns are accurate, is singularly instructive. In drawing any inference on this subject, we should treat Great Britain separately from Ireland, as the importation of cattle from this part of the United Kingdom is more difficult than it would be from Belgium or France, and nearly as difficult as from Denmark and the Elbe. In round numbers the population of Great Britain is about 24,000,000. In one particular only, that of sheep, is Great Britain on a general level with other countries. There is nearly a sheep to every head of population, but of horned cattle there is only one to about every five; of pigs only one to every nine. Were the amount of horned cattle in France proportionate only to that of Great Britain, France would have a little more than 6,000,000; in fact it has rather more than 14,000,000. The same may be said of Austria. In many of the German States the proportion is higher still. In Denmark the cattle are not very much less numerous than the population. In the United States there is rather more than one head to every two of population. With pigs, as I have stated, Great Britain is very scantily provided. In France and Prussia pigs are one to seven; in Austria one to four and a half. Taking the whole of Europe, the proportion is one to six. In the United States there are more pigs than population. Had the returns supplied us with information as to poultry, the deficiency would have been still more striking. In the year 1865 this country imported more than 400,000,000 of eggs, if the hundreds of eggs be taken, as it has been from the earliest time, at 120. I need hardly inform my hearers of the fundamental canon of prices—that when the supply of any necessary of life falls short of the demand, the price rises in a proportion which I may perhaps venture on calling geometrical; that is, the quantity available for sale is worth increasingly more, according to the deficiency, than the normal or natural supply would be. The statistics of the cattle returns supply the key towards interpreting the high price of meat, and we may be sure that the price of meat would be higher than it actually is were it not for those improvements in stock keeping by which cattle becomes more available for consumption at earlier dates—improvements which are yearly developed. This deficiency is not greatly supplemented by importation. Small as the stock of cattle is, the annual importations do not amount to more than one-twentieth of

the ordinary stock, while that ot sheep is, as a rule, but one-fiftieth. During the present year even these quantities must have undergone a serious diminution. Nor is the import of meat large. The most important item is that of bacon. But even here the largest estimate will not give more than the equivalent of 300,000 pigs. The beef seems to be about equal to the supply of 50,000 oxen. It is matter of regret that no facts have been collected by which we might compare the present and past supply of live stock in Great Britain. It is of course always dangerous to trust to impressions or to memory, but I cannot but be convinced that there has been a general and considerable diminution in the amount of live stock in Great Britain for some years past. It is now comparatively seldom that agricultural labourers are able to keep pigs; it is still more rare that they breed poultry. The enormous importation of eggs suggests that the fowls kept in Great Britain are comparatively scanty. But it is probable that the maintenance of insect-eating birds is an important provision in agricultural economy, and that when we find fault with the destruction of small birds we forget that our practice is dispensing with a still more important means for checking the ravages of insects, as well as for supplying that great deficiency in live stock which seems to characterise our domestic economy. It is possible too, that the abandonment of much pasture in the northern part of the island to deer forests and grouse moors has considerably lessened stocks of lean cattle and mountain sheep. It is a little dangerous to offer any comment on the second important contribution to the statistical information of the present year. Under existing circumstances we must, if we allude to the electoral statistics, remember the caution of the Roman poet:—

> "Incedis per ignes
> "Suppositos cineri doloso."

It will be clear, however, that valuable as the Blue-book is to which I am adverting, and singular as were some of the obvious inferences from its contents, the facts are imperfect and the tabulation still more so. One would have desired to see, along with the figures declaring the value of lands and tenements as estimated for income-tax, other similar charges, such as the proportion of assessed taxes, and the amount of the poor-rate. It would have been well also had the distribution of the 25 per cent. of "working classes" among the several constituencies been distinctly indicated. Thus, for instance, the persons designated by this name amount to nearly half the constituency of Birkenhead; to not much less in Nottingham; whereas at Birmingham they are taken at less than a fifth, at Bradford, considerably under a tenth. Is it possible that the expression "working classes" has been variously interpreted by those who transmitted their reports to the Poor Law Board? But as the returns published in this Parliamentary paper are of considerable interest, it may be confidently expected that the facts will be tabulated in a fuller manner hereafter, as they are keenly criticised at present. It might be expected that there would be a close conformity between values at very remote periods of social history. The proportions subsisting between the prices of labour and food are, or should be, so close and unvarying, that we may always suspect, in fully settled countries at least, that any marked discrepancy between values at different periods is suggestive of removeable evils. For instance, if the price of food is considerably in excess of the average rate of wages, some cause, which may be eliminated or corrected, can almost always be assigned for the phenomenon. I may mention here in illustration of this rule that during the 13th and 14th centuries the prices of barley and oats, wheat being taken at 100, are represented by the numbers 73·14 and 42·03, and that within the last ten years the numbers have been 70 and 45·95. Close as this relation is, the slight discrepancy may, I think, be accounted for by the incidence of the malt-tax in the first case, and the great increase in the number of horses kept in the second. Other concurrent causes may, I make no doubt, be detected, but these, I think, are likely to be the most dominant. Estimates as to depreciation and exaltation in the value of the precious metals are, however, to be made with extreme caution, because they are liable to many fallacies. Some of us may remember the alarms entertained by M. Chevalier as to consequences likely to be effected on prices by the gold discoveries. It is not, I think, too much to say that these fears, though natural, were grossly exaggerated. For in order that such inductions should be valid, they should be taken from a very wide area, and many disturbing causes should be accounted for or eliminated. The effects of unfavourable seasons and interrupted importations—it is only twenty years since the country accepted the principles of free trade, several years less than twenty years since it has experienced the advantage of that policy—should be recognised in interpreting the money value of the first necessaries of life; while the effects of speculative purchases and forced sales are equally dominant in the price current of its conveniences. To interpret a rise and fall in the value of money (the efflux and influx of which, as a merchantlike commodity, is inevitably more free than that of any other article of value) by the money measure of that which is open to a vast variety of influences, must be an operation in which infinite caution is necessary, in order to prevent the inference from becoming wholly untrustworthy or delusive.

Professor Leone Levi read a paper "On the State and Prospects of the Rate of Discount with reference to the recent Monetary Crisis." Having shown the great importance of the question as it affected the value of property generally, and indicated the immense losses produced by the sudden rise from 4 to 10 per cent., he showed that 10 per cent. was the rate allowed during the reign of Henry VIII. and Queen Elizabeth; that in 1624 the legal rate was reduced to 8 per cent., during the Commonwealth to 6 per cent., and under Queen Anne, in 1714, to 5 per cent., at which rate it stood till the abolition of the Usury Laws in 1839, the Usury Laws and a comparative stagnation of business being the reason why the rate continued so long with little variation. During the pressure of 1839 the rate rose to 6 per cent., but it soon fell to 4 per cent., at which rate it was when the Bank Charter Act passed in 1844. Then the Bank of England resolved to make their rate of interest fluctuate with the rate of supply and demand of money, taking the state of their reserve as a guide. The paper then gave a summary view of the action of the Bank in this respect at different times, and the proportion between the reserve and liabilities to the rate of interest as follows:—

	Liabilities. £		Reserve. £		Proportion. per cent.		Rate of Interest.
On the passing of the Act ...	13,305,512	...	9,032,790	...	67	...	$2\frac{1}{2}$ to $3\frac{1}{2}$
October, 1847	15,073,986	...	3,075,115	...	20	...	8
May, 1852	18,724,558	...	12,069,240	...	64	...	2 to $2\frac{1}{2}$
" 1857	21,860,000	...	4,400,000	...	20	...	10
" 1861	19,871,577	...	5,619,994	...	28	...	9
" 1866	25,186,713	...	1,202,810	...	5	...	10
August, 1866	22,172,744	...	4,610,866	...	8	...	8

The professor showed that the entire capital of the country was in a manner represented in the small reserve at the Bank, from the fact that all the banks keep their balance at the Bank, which are affected by the state of trade. The exclusion of the greater portion of bullion at the Bank from the reserve arose from the division of the Bank into two departments which received the amount to cover the extra issue of notes beyond the authorised amount. The rate of interest in the last 20 years has been progressively higher. From 1845 to 1849 the average was £3 11s. 7d.; 1850 to 1854, £3 5s. 11d.; 1855 to 1859, £4 11s. 8d.; 1860 to 1864, £4 15s 3d.; to 1865, £4 16s. Compared with France and the United States, from 1831 to 1865, the rate in the latter country has been uniformly higher, frequently touching extreme limits, as in 1834, 15, 16, and 24 per cent.; in 1837 and 1839, 24 to 26 per cent. As between France and England in the last 37 years it was equal in both countries in 12 years; lower in this country in 9 years; higher in this country in 15 years. What were the reasons, then, that with the great increase of wealth in this country the rate was higher now than twenty years ago, and higher in this country than in France? Some reasons were of a permanent character. First was the large increase of trade. While in 1849 the exports amounted to £63,000,000, in 1865 they were £165,860,000. The imports in 1854 amounted to £152,000,000; in 1865 to £271,000,000. Shipping increased in the same proportion. A second cause was the annual exportation of the precious metals to the East. A third was the immense numbers of joint-stock companies. In 1864 and 1865, 832 companies had been formed, with an authorised capital of £362,935,000. Great amounts of capital had been invested or prepared to be invested in public works. In the Session of 1865 the amount authorised to be raised was £126,000,000; in 1866 it was £175,500,000. But some causes were of a temporary character, such as the bankruptcies of banks, an universal demand and want of confidence and eventual alarm among the commercial classes. The Bank Charter Act was considered by many to have a good share of influence in increasing the monetary pressure. It was questioned that the issues can at any time be in excess of actual wants, and the opinion was general that in any case discretionary power should exist somewhere to act as circumstances dictated. The author sympathised entirely with the view advocated on this subject by Messrs. Tooke, John Stuart Mill, Nemarch, and others, and he was of opinion that the Bank Charter Act greatly intensified the panic and danger in time of crisis. But clearly it was idle to charge that with the blunder and rashness exhibited by the operations of many banks. What would restore the rate of interest to its normal state would be a contraction of liabilities, the spreading of many of the public works over a large number of years. Trade was otherwise in a solid condition, prices were not high. Speculation, if any existed, had been effectually checked. "To conclude," he said, "just as presence of mind and cheerfulness greatly contributed even in the midst of an epidemic to comparative preservation, so in a period of commercial panic the best safeguard to our own stability is the maintenance of a calm and undisturbed judgment (as far, indeed, as it is possible) in the ordinary course of business. There is a magic power in public confidence. No greater calamity could befal a commercial community than the sudden breaking asunder of this electric chain, which binds together all the great interests of the empire. As far as we can see the commerce of the country is solid and prosperous. If a cloud now and then obscures the horizon it is only to make the sunshine more grateful and enduring; and even should a storm unhappily arise, destroying in its course the lighter craft, those, namely, which are but ill manned and ill prepared, we shall soon find that, better taught by experience, and even humbled by temporary misfortune, trade will once more enjoy a long season of progress and prosperity."

The paper was followed by an interesting and animated discussion.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page* 187).

Looking to the average of the 93 analyses, it will be observed that the sewage contained about $87\frac{1}{2}$ grains per gallon of total solid matter, of which about two-thirds was inorganic, and one-third organic. About half of the total solid matter was in suspension, and half in solution; of the half in suspension about four-sevenths was inorganic and three-sevenths organic, and of the half in solution, about four-fifths inorganic. Lastly, of the nitrogen reckoned as ammonia, about one-fourth was in suspension, and three-fourths in solution.

The mean of the 93 analyses shows about $6\frac{1}{2}$ grains of ammonia per gallon, indicating a value of about $1\frac{3}{4}$d for the total constituents of 1 ton of the sewage. But taking into consideration the fact that the samples

were not collected at exactly equal intervals throughout the whole period, it is concluded that, hy taking the mean result for each of the 31 months separately, and then the mean of the 31 means so ohtained, the result will more nearly represent the real average composition of the sewage of the whole period, than will the direct mean of the 93 analyses; and the calculated average so obtained indicates about 7, instead of only 6½, grains of ammonia per gallon.

From all the information at command as to the population contributing to the sewers, the water snpply, the rainfall, and the drainage area, it was concluded that, taking the average of seasons, there are about 60 tons of sewage per head of the population of Rugby, per annum; but that, as the period of the experiments was drier than usual, the amouut prohahly then reached to only about 55 or 56 tons.

Now, if we reckon 6½ grains of ammonia per gallon, and 60 tons of sewage per head per annum, it would result that 12½lbs. of ammonia were contributed annnally for each average individual of the mixed population, of both sexes and all ages; or, if we reckon 7 grains of ammonia per gallon, and 56 tons of sewage per head per annum, we equally arrive at the amount of 12½lbs. of ammonia per head per annum; and from a careful consideration of the Rughy results, it was concluded, at the time the report was issued, that this probably very nearly represented the actual truth.

Having, then, hy means of the results of a great many analyses of sewage, and a consideration of the amount of sewage contributed by each average individual of the population, estimated that for each such average individual there would be about 12½lbs. of ammonia contributed to the sewer-water, let us next see what result is arrived at by the other method of computation which has been referred to, namely, by the calculation of the amounts of fæces and urine, or of tbe various constituents of these, recorded as voided by persons of different sexes and ages. Table IV. very coucisely summarises the information available on this subject, so far as it is necessary for our present purpose.

Table IV.

Amount of Nitrogen reckoned as Ammonia, and estimated value of total Constituents in Human Voidings, per head per annum.

	Ammonia.	Value of Total Constituents.
Adult Males; Hofmaun and Witt.		
	lbs.	s. d.
Urine	15·8	10 0½
Fæces	2·3	1 8¾
Total	18·1	11 9¼
Adult Males; Thudichum.		
Urine	15·9	10 3½
Average, both sexes and all ages; Hofmann, Witt, and Thudichum.		
Urine	11·32	7 3
Fæces	1·64	1 2¾
Total	12·96	8 5¾
Average, both sexes and all ages; Lawes and Gilbert.		
According to Food	12·2	8 4
According to Voidings	12·6	
According to Voidings	12·7	
Mean	12·5	

To check their estimates founded ou the aualysis of the twenty-four-hours' mixed sample of the Savoy-street sewage, Messrs. Hofmann and Witt took the amount of urine estimated to be daily voided by an adult, and the amount of fæces recorded as voided on the average per head of the hody-guard of the Grand Duke of Hesse Darmstadt (but allowing, as they said, a little more for "John Bull"), and applying the results of Berzelius' analysis of urine, aud those of the analyses of Way, Liebig, and Wesarg, of fæces, they calculated the amount of ammonia and other constituents, daily voided hy such persons. According to their data, the amount of ammonia annually voided by an adult male was in urine 15·8, in fæces 2·3, total 18·1lbs.; and the estimated money value of the constituents was in urine 10s. 0½d., in fæces 1s. 8¾d., total 11s. 9¼d. The result so obtained for adult males they take as applicable to each individual of a mixed population, of both sexes and all ages, assuming that other matters reaching the sewers would probably make up the difference. There can be little doubt that this was making far too liberal an allowance for other than human excretal matters contributing to the value of the sewage.

Some years later, in 1863, Dr. Thudichum, from mnch more comprehensive data, gave for the urine alone of an adult male 15·9lbs. of ammonia, and 10s. 3½d. of value; amounts which, it will be seen, are almost identical with those of Messrs. Hofmann and Witt.

But Dr. Thudicum, instead of directly applying the results obtained for an adult male to each avererage individual of a mixed population, considered that two adult males would approximately represent 2·8 such average persons. Now, if we take the mean of the estimates of Messrs. Hofman and Witt, aud Dr. Thudichum, with regard to the urine, and those of Messrs. Hofmann and Witt with regard to the fæces, of an adult male, and reduce both in proportion of from 2·8 to 2, according to Dr. Thudichum's basis of calculation, we shall, provided the estimates of these autborities be correct, arrive at amounts approximately applicable to an average individual of a mixed population of both sexes and all ages. By this process, as the Table shows, we have nearly 13lbs. of ammonia, and nearly 8s. 6d. of value, to represent the mixed voidings of snch an average individual.

In 1854, the authors, hasiug their estimates on very comprehensive data, relating both to the amounts of constituents consumed in the food, and voided in the urine and fæces, of persons of different ages and both sexes, concluded that probably about 10lbs of ammonia, and total constituents of the estimated manurial value of about 6s. 8d., were unnually contrihuted to sewage per individual of a mixed town population. More recently, for the purposes of the report of the Royal Sewage Commission, all the estimates relating to the constituents voided were carefully revised, bringing into the calculation such further information as was then at command;* and the results so obtained are recorded in the Tahle IV.

The amount of nitrogen estimated to he annually consumed in the food of an average individual was deduced from the calculation of 86 dietaries, arranged in 15 classes, according to sex, age, activity of mode of life, and other circumstances, and corresponded to about 12·21lbs. of ammonia; from which, of course, a deduction has to be made for the nitrogen retained in the body, and for loss in various ways. When the calculation was based upon determinations or computations of the amounts of nitrogeu or ammonia-yielding matters voided hy persous of different sexes and ages, the result arrived at was 12·6lhs. of ammonia; and when upon the recorded amounts of fresh urine and fæces voided, and the average composition of these, the amount indicated was 12·7lbs. of ammonia per head per annum. A careful consideration, however, of the circumstances of the majority of the cases contrihuting to the averages among those divisions of the population in relation to which the evideuce is the most plentiful, and of the relative character of the results where it is the most deficient, led to the conclusion that the estimate of 12·6 or 12·7lhs. for the amount of ammonia voided annually by an average individual of a mixed population, was in all probahility too high.

Reviewiug the whole of tbe evidence, hoth that relating to the composition and the amount of the Rugby sewage, and that relating to the amount of constituents voided hy an average individual, it was concluded that tbe amount of ammonia annually contributed to the sewer-water by an average person of a mixed population was pretty certainly more than 10lbs., as formerly assumed, hut probably less than 12lbs.; and, making allowance for the fractional part of the excretal matters of horses, cows, dogs, and other animals, of the refuse of slaughter-houses, of soot, and of other refuse matters that may reach the sewers, it was concluded that still not more than 12½lbs. of ammonia would bc contributed annually to the sewers from all sources, per head of mixed town population. This would indicate an estimated value of 8s. 4d. per annum for the total constituents in the sewage for each average individual.

It was admitted, however, to he a great desideratum, that when the

* For nearly the whole, if not the whole, of the data upon which the new estimatese are based, *see* "On the Sewage of London," by J. B. Lawes, F.R.S., Journal of thd Society of Arts, March 9th, 1855; "The Composition of the Urine in Health an- Disease," by E. A. Parkes, M.D., 1860; "On an Improved Mode of collecting Excre mentitious Matter with a view to its Application to the benefit of Agriculture, &c.," by J. L. W. Thudichum, M.D., F.C.S., Journal of the Society of Arts," May 15, 1863; and "On the Elimination of Urer and Urinary Water, in relation to the period of the Day, Seasou, Exertion, Food, &c., &c.," by Edward Smith, M.D., LL.B., F.R.S., Philosophical Transactions, vol. cli, p. 747.

Main Drainage of the Metropolis came to be completed, and the works to be in full operation, competent persons should be appointed to superintend the gauging, sampling, and analysis of the sewage, with a view to providing data which might serve to determine satisfactorily and conclusively the approximate amount, and average composition, of the Metropolitan sewage, as it will have to be dealt with in any plan of utilization, and also the relation of population to the composition of sewage generally.

Since the publication of the Report of the Commission, in March 1865, numerous gaugings and samplings of the sewage of the mid and high-level sewers north of the Thames have been undertaken and many samples have been analysed by Mr. Way. The results of this inquiry have not yet been published; but from information kindly communicated by Mr. Way, we are enabled to state their general bearing, so far, upon the point now under consideration.

From these new results it appears very probable that the amount of dry weather, sewage averages only about two-thirds as much per head of the population as that generally supposed before, and assumed both in the inquiries of Messrs. Hofmann and Witt, and in the report of the Sewage Commission; but the average amount of ammonia per gallon now found by Mr. Way in the dry weather sewage very nearly approaches that arrived at by Messrs. Hofmann and Witt. Both Mr. Way and Mr. Cresy frankly admit, however, in accordance with common experience the further a subject is investigated, that there are still many open questions, the settlement of which may materially affect the proper interpretation of the new gaugings.

Assuming them to indicate the result at present supposed, and above stated, it follows that the total amount of ammonia yielded by a given population will be only about two-thirds as much as that estimated by Messrs. Hofmann and Witt, on applying the results of their analysis to the higher estimated amount of the dry weather sewage. It further follows, from the same evidence, that the amount of ammonia annually contributed to the sewage, from all sources, per head of a mixed population, is more nearly 10lbs., as formerly concluded by the authors, than 12½lbs., as more recently estimated; and if this result should be confirmed, their former estimate of 6s. 8d. will more nearly represent the calculated annual value of the total constituents yielded per head of the population than the more recent one of 8s. 4d. It would then have to be concluded, as indeed is not improbably the case, that, in the calculations, based on the mean composition and the estimated total amount of the Rugby sewage, the latter had been taken at too high a figure, too large a proportion of the rainfall having been assumed to reach the sewers; and that, in the estimates founded on the recorded amounts of constituents voided, the incompleteness of the records, as already pointed out, had, as was supposed, led to too high an estimate.

We have, then, from 10 to 12½lbs. of ammonia, and an estimated value of from 6s. 8d. to 8s. 4d. for the total manurial constituents, contributed to sewage by each average individual of a mixed town population. Adopting these amounts, the questions arise—What will be the amount of ammonia, and what the estimated value of the constituents, in a given amount of sewage, at different dilutions? These points are illustrated in Table V.

TABLE V.

Ammonia, per gallon, and estimated value of total Constituents in one ton, of Sewage at different dilutions.

Dilution supposed.		If 12½lbs. Ammonia per head per annum, from all sources.		If 10lbs. Ammonia per head per annum, from all sources.	
Per head per annum.	Per head per day.	Ammonia per gallon.	Estimated value per ton.	Ammonia per gallon.	Estimated value per ton.
Tons.	Gallons.	Grains.	Pence.	Grains.	Pence.
40	24½	9·77	2·44	7·81	2·00
50	30¾	7·81	1·95	6·25	1·60
60	36¾	6·51	1·67	5·21	1·33
70	43	5·58	1·43	4·46	1·14
80	49	4·88	1·25	3·91	1·00
90	55¼	4·34	1·11	3·47	0·89
100	61¼	3·91	1·00	3·13	0·80
200	122¾	1·95	0·50	1·56	0·40

According to the information supplied to Messrs. Hofmann and Witt, the dry weather sewage of the Metropolis amounted to between 36 and 37 gallons per head per day = about 60 tons per head per annum. Their analysis showed 8·2 grains of ammonia per gallon, equivalent to about 15⅔lbs. of ammonia per head per annum; and they reckoned the total constituents in one ton of such sewage to be worth 2·11d. But Table V. shows that with a dilution of 60 tons, and with 12½lbs. of ammonia per head per annum, there would be only 6·5 grains of ammonia per gallon, and total constituents in one ton of sewage worth only 1⅔d.; and that with only 10lbs. of ammonia per head per annum, there would be only 5·2 grains per gallon, and constituents worth only 1⅓d. in one ton of the sewage.

If, however, we take the dry weather sewage as indicated by the recent gaugings as more nearly 24 gallons per head per day = a rate of 40 tons per head per annum, we have then, with 12½lbs. of ammonia per head per annum, 9·77 grains per gallon, and 2·44d. worth of constituents per ton; or, taking 10lbs. of ammonia per head per annum, we have 7·8 grains per gallon, and constituents in one ton of an estimated value of nearly 2d. Now, Mr. Way's conclusion is, that the mid and high-level dry weather sewage north of the Thames averages scarcely, but nearly, 8 grains of ammonia per gallon, or almost exactly the amount last mentioned; and as Messrs. Hofmann and Witt's analysis shows 8·2 grains, it will be seen that both estimates, taken in connection with the amended one as to the daily amount per head of the dry weather sewage, go to confirm the assumption that the amount of ammonia contributed to the sewage from all sources is much more nearly 10 than 12½lbs. per head per annum.

Whatever may eventually prove to be the average dilution of the dry weather Metropolitan sewage, the actual amount of fluid varies immensely from time to time, according to rainfall and other circumstances. When it exceeds a certain amount, as in the case of continuous rains or storms, a portion will pass at once into the Thames; and according to Mr. Bazalgette's figures it appears that this will happen when the volume is such as, if continuous, would represent something over 200 tons of fluid per head per annum. But, so far as information at present at command enables us to judge, it is probable that the amount, inclusive of rainfall and subsoil water, that will be available for utilization, will be somewhere about 80, and will pretty certainly not exceed 100 tons per head per annum; that is, about twice, or not more than twice and a half, as much as the most recently estimated dry weather flow. Of course, to result in anything like such averages, the dilution would sometimes be at a rate very much greater than those amounts would indicate. But it may be observed, by way of illustration, that with 12½lbs. of ammonia per head per annum, and an average of 80 tons of sewage, it would average less then five grains of ammonia per gallon, and only 1·25d. worth of constituents in one ton; or, reckoning an average dilution of 100 tons, it would average less than four grains of ammonia per gallon, and only 1d. of value of constituents in one ton. In like manner, reckoning only 10lbs. of ammonia per head per annum, a dilution of 80 tons would show less than four grains, and of 100 tons little over three grains of ammonia per gallon, and an amount of constituents in one ton worth only 1d. and 0·8d. respectively.

In comparison with the figures just given, it may be stated that both Baron Liebig, and Mr. Thomas Ellis (one of the applicants for the concession of the Metropolitan sewage) assume its total amount at 266,000,000 tons per annum, which, with 3,000,000 population, represent nearly 90 tons per head per annum, and with this dilution the former estimates the sewage to contain an average of 7·2, and the latter 8·2 grains of ammonia per gallon; the latter, as already stated, applying the estimate of Messrs. Hofmann and Witt for the dry weather sewage to the total estimated amount of available sewage, inclusive of rainfall.

It is sufficiently obvious that, however variable the dilution of the constituents in town sewage, large quantities will have to be dealt with. It will be useful, therefore, by way of illustration, and as a means of conveying a more definite idea of the extent of this dilution, to show the relation of a given amount—say 1,000 tons—of sewage of certain assumed dilutions, both to population, and to some well-known portable manure, such as Peruvian guano. This is done in Table VI, which shows the amount of guano which would supply as much nitrogen reckoned as ammonia as 1,000 tons of sewage of different dilutions, also the number of tons of sewage which would be equal in this respect to one ton of guano, and both on the alternative assumptions of 12½lbs., and 10lbs., of ammonia per head per annum. The assumed dilutions are 40, 50, and 60 tons per head per annum, which may be taken to cover the minimum and maximum estimated rates of flow for the dry weather sewage of the Metropolis; 80 and 100 tons, which may be taken to represent the range for the average total available sewage, inclusive of rainfall and subsoil water, and 200 tons, the probable frequent dilution in wet water.

(*To be continued.*)

THE WORKING PROCESSES FOR THE REDUCTION OF THE GREY COPPER (TETRAHEDRITE) ORES AT STEFANSHUETTE, IN THE COMITAT (COUNTY) OF ZIPS, IN HUNGARY.

By J. L. Kleinschmidt.

(From the Journal of the Franklin Institute.)

The proper working of the grey copper ores is one of the most difficult metallurgical processes. At the Stefanshuette it is now done on a larger scale than anywhere else in the world. These works, which received a prize medal at the London Exhibition of 1862, were established sixteen years ago, and produce, at present, about 300 tons of copper, 3,000lbs. of silver, 60,000lbs. of quicksilver, and 80,000lbs. of crude metallic antimony. The works built for the smelting of the grey copper, use of yellow ores only poor quartzose ones, which are necessary for fluxing. The processes, therefore, have a character quite different from that in other places, where the grey copper ores form only a small part of the materials to be melted. One of the main progresses in the last years is the production of metallic antimony from grey copper ores, since more than one-half of the regulus antimonii, which comes in the market from Hungary, is now produced from these ores.

The pure grey copper ores contain, according to the analysis of Von Hauer (Jahrbuch der Geolog. Reichsanstalt, 1852. Heft 4, page 102.)

	I.	II.	III.	IV.	V.	Name of the Mine.
S	25·90	13·38	24·37	24·89	22·00	1. Bind Appolonia.
Cu	36·59	34·23	30·58	32·80	39·04	II. Andræi.
Fe	7·11	9·46	1·46	5·85	7·58	III. Gustav Frederici..
Hg	3·07	3·57	16·69	5·57	0·52	IV. Heil. Geist. Tr.
Sb	.26·70	33·33	25·48	30·18	31·56	V. Rothbaum.
As	trace.	trace.	trace.	trace.	trace.	
	99·37	99·97	98·58	99·29	100·50	
Spec. G.	4·605	4·762	5·107	4·733	4·582	

The above ores contain from $\frac{1}{8}$ to 3ozs. of silver in 100lbs., the average yield of the ores being $\frac{5}{8}$oz. Besides these, ores are furnished to the smelting works, which contain *no* quicksilver; the ores are therefore separated into two classes —in those containing quicksilver and in those free from it. The veinstone of the mercurial ores consists almost exclusively of carbonate of iron. The other minerals, which are associated and intermixed, sometimes do not amount to 1 per cent. of the sparry iron. The average yield of copper is 10 per cent. Besides grey copper ores, the ores contain about 3 per cent. of yellow copper ores; so that they consist of grey copper ores 2 per cent., yellow copper ores 3 per cent., carbonate of iron 69·3 per cent., other minerals, as heavy spar, slate, quartz, and calcareous spar 0·7 per cent. The ores therefore contain about 7 per cent. of sulphur, and 8 per cent of antimony. The annual production is about 2,500 tons of ores, containing about 400,000lbs. of antimony.

Separation and Collection of the Mercury.—The great volatility of this metal requires that it should be separated first. The process is a very simple one, but nowhere else in use, and consists in the roasting of the ores in large round furnaces, and collecting the quicksilver in the upper layer of the ore. On the bottom of the furnace is placed a layer of fine ore of 4in. in thickness, then follows a layer of wood of 22in. and on this 6in. of charcoal. Now follow layers of partly roasted ore, but not yet free of quicksilver. The fine ore is added in stripes radiating from the centre, whilst between these the lumps are placed, otherwise the furnace would have no draft. Therefore the ores, which have been once roasted, but yet contain mercury, are separated by sieves into fine ore and lumps. Uppermost come the fresh unroasted ores, and the top layer, in which the quicksilver is condensed, consists of lumps only of different sizes (Stufen and Graupen). The whole quantity amounts to 50 tons, and forms a layer about 2ft. high. A wood-pile is in the centre of the kiln, from which it is fired and burns during about four weeks. In consequence of the heat produced by the burning of the ores, the mercury is volatilised, and passes through the upper layers of the ore, where it is condensed in the form of globules. It is only necessary that these remain throughout and at all times cold, and that the places which perhaps get warm are at once covered with cold lumps to prevent the loss of mercury; therefore watchmen are at the furnaces, day and night, during the whole process of operation.

After the kiln is burnt out, the upper layer, which is full of metallic quicksilver, is cautiously taken away, and washed in wooden tanks by the help of sieves, as is done in the washing of ores. The quicksilver goes through the sieve, and remains with the ore dust on the bottom of the tank. From the latter it is separated by boys, who wash it in small wooden troughs. For this purpose in a building are three tubs containing water, and on each of them stand three or four boys, ten to sixteen years old. Every one takes some of the mixture of dust and quicksilver in his trough (Sichertrog), and, keeping it below water edge, he gives it a great many small shocks against the wall of the tub, whereby the quicksilver settles to the bottom of the trough. The water of the tub is mixed with some quicklime, otherwise the quicksilver would contain copper. That part of the roasted ore which yet contains quicksilver is worked over a second time, as described above; the lower portion, however, which is free of mercury, goes to the furnace. The quicksilver obtained is not pure; it contains silver and copper, and must be distilled in an iron retort. The distillation must be conducted very slowly, otherwise traces of copper are also volatilized. If carefully done the distilled mercury contains no foreign substances, except sub-oxide of mercury. Formerly, when the distillation was done too rapidly, the quicksilver sometimes contained traces of copper. The residuum in the retort consists of ore dust and metallic silver, the latter containing copper and gold.

After the roasting, almost the entire lower part is melted together, and most of the sulphur has combined with the iron of the sparry iron. The volatile products formed by the roasting have a strong smell of sulphurous acid and bisulphuret of carbon. Besides the smoke of wood, there are generally no other vapours emanating from the roasting kiln. Sometimes arsenious vapours can be perceived. In this roasting process there are never observed the dense vapours which arise by the roasting of the matte (Lech), but the atmosphere contains only an invisible gas, which acts seriously on the eyes and lungs.

The yield of the ore by this process is 94 per cent. of the mercury, found by assay. In former times a great many and costly experiments were made to distill the quicksilver in retorts, furnaces, and every possible apparatus, and to condense it then in chambers and pipes placed in gold water; but the above simple method, by which fresh cold ore is employed for the condensation of the quicksilver, has superseded all others.

In relation to the chemical process, the protoxide of iron of the sparry iron may have a prominent part in driving out the mercury, because the melted mass on the bottom of the furnace consists partly of sulphuretted metals and partly of antimonial metals (Speiss). Most grey copper ores give out metallic mercury by heating them in a sealed glass pipe; in others, here and there red cinnabar can be seen. The latter yield the mercury only by heating them in an open pipe, so that we have three causes here, by which the quicksilver is set free:—1. The heat alone. 2. The oxygen of the air; and 3. The influence of the oxide of iron. The average yield of the ores amounts to 1·63 per cent. of mercury.

Matte Smelting (Rohschmelzen).—After the separation of the mercury the ore is smelted. The mixture consists of roasted ores with about 40 per cent. of the crude grey copper ores, free of mercury, and to 100 of this mixture are added six parts of iron pyrites of Schmöllnitz, twenty parts of poor quartzose ores, and twenty parts of slag of the melting of the roasted matte (Lech).

Qualities and Composition of the Materials.—It was above mentioned that the lower part of the roasted heap, which is free of quicksilver, consists of sulphurets and antimoniurets of metals. Above it is a layer, also free of quicksilver, consisting chiefly of peroxide of iron, and very little protoxide. The carbonate of iron is in this layer very rare, as it has mostly been changed into peroxide.

The composition of the raw ores can be stated as follows: grey copper ores 26 per cent., yellow copper ores 4 per cent., sparry iron 64 per cent., slate and quartz 4 per cent., and arsenical iron 2 per cent., and about 2 ounces of silver in 100lbs., which is more than the average yield of the mercurial grey copper ores.

Pyrites of Schmöllnitz.—These are bought from several companies, which work, besides the Austrian government, on the well-known deposits of pyrites called the Kiesstock. These pyrite ores give, by the crucible assay, 70 per cent. of matte (Lech), contain one-eighth of an ounce of silver in100lbs., and less than $\frac{1}{2}$ per cent. of copper, $\frac{1}{2}$ to 4 per cent. of lead, and small quantities of zinc antimony, and arsenic.

Quartzy Flux Ores.—These are yellow copper pyrite ores disposed in quartz. The average yield of these ores is from 3 to 6lbs. of copper in 100lbs. They contain only small quantities of iron pyrites, arsenical iron, sparry iron and grey copper ores. These ores are received at the melting works about one-third in lumps of about an inch in diameter, and two-thirds as ore dust (Scheidklein).

The furnaces employed for the melting are so-called half-high furnaces, of the following dimensions in Austrian measure. From bottom stone to the mouth $24\frac{1}{2}$ft., from bottom stone to the tuyeres 6ft., from the tuyeres to the cinder hole, downwards, measured 29in., height of the boshes $1\frac{1}{2}$ft., inclination of the boshes 45°, width of the bottom of the hearth $3\frac{1}{2}$ft., width of the boshes 5ft., of the mouth 18in. The furnaces are circular, and the two tuyeres blow in the centre of it. They have a diameter of $1\frac{1}{4}$in. on the mouth. The pressure of the air is seven-twelfths to ten-twelfths inch quicksilver. The rough mason work of the furnaces is of slate—the interior shaft of fire-proof talcose slate. They stand on a foundation 15ft. high, which lays on solid rock. The melting is done by a half-lighted nose, and one furnace melts in twenty-four hours 5 tons of ore.

The cinders or slags are tapped every fifteen minutes, and the tapping hole is stopped with loam. There are prepared several small but deep crucibles (Tiegel) in front of the furnace, united by a kennel. The last consists in a flat hollow of 7 to 8ft. in diameter, which is called *sump* (Sumpf). In the first of the crucibles, whilst the melted metals take their way through them, the "speiss" is deposited, covered by a layer of matte (Lech) but the most of the latter goes to the sump, in which it hardens to a layer of 1 to 2in. in thickness, and while yet warm is broken to pieces. As soon as the tapped metals are cold, the smelter takes away the solid matte by a fork (Forkel) and when he comes to the speiss he puts in it a piece of iron, which has a ring above, by means of which he takes it out after cooling.

I have found the composition of the products of the matte melting (Roschmelzen) to be—

Matte (produced Feb. 1864).		Speiss (produced June 1864).	
Cu	22·10	Cu	26·93
S	25·80	Sb.........................	62·41
Fe	47·62	Fe.........................	8·91
Sb.........................	3·37	Co. & Ni.........	0·20
Ag	0·08	S	1·37
Slag.........................	1·40	Ag	0·20
	100·37		100·02

Slag (Rohschlacke) (produced Feb. 1846.)

SiO_3	46·60
S	2·24
Sb	0·80
Cu	0·40
FeO	42·21
CaO	3·78
MnO	2·60
Al_2O_3	0·80
	99·43

Conditions for the Formation of the Speiss.—The formation of the speiss was known to me already in 1847, when I became acquainted with it at the Imperial Altwasserhuette, where, at that time, the same grey copper ores were worked up, which are now used at the Stefanshuette. In 1853 I was engaged on the melting works of Wissenbach, near Dillenburg, in the Duchy of Nassau, Germany, in finding a method for the profitable working of the grey copper ores of that district. The veinstone of these ores, renowned for the beauty of the crystals and the scarcity of their occurrence, consists of quartz. I added slag from puddling furnaces, slag from the melting of roasted copper matte, and some lime, but no speiss was obtained. I soon found that the production of speiss depended upon the presence of metallic iron in the melting process. I obtained speiss without difficulty by the direct addition of wash iron (from the stamping of slag of an iron furnace) as also by that of roasted sparry iron. The matte melting (Rohschmelzen) of the Stefanshuette does, therefore, not produce any secretions of metallic iron (Eisensauen, Salamander) as it is the case at the Phœnixhuette and other melting establishments, belonging to the same association, and where the yellow copper ores are melted, because, instead of the iron, and by the aid of it, the easily fusible antimony is separated.

So long as it was not possible to extract the silver from the speiss by amalgamation, its appearance was not liked. The desideratum was to make as small a quantity as possible, and several times experiments were made to avoid its production altogether. Only recently a method was discovered to separate, by amalgamation, the silver from the speiss with the same facility and quite as perfectly, as from the black coppers. Besides this, a method was found to reduce the yield of copper in the speiss to such an extent that the copper in the crude antimony is more than paid, so that it is now perfectly reasonable to reduce more and more the addition of the pyrites, which prevented the formation of too large a quantity of speiss, and to produce more speiss, and to work it up by itself. Not taking into consideration the considerable quantity of antimony, which thereby is gained, the main profit is in the diminution of the by-products; further on we will see that the working up of these forms a great part of the operations of the Stefanshuette, and that it is certainly easier to separate the antimony at once than to volatilize it by an endless series of processes. The second reason is that thereby a much better copper can be produced. It will be seen from the analysis below, that cobalt and nickel go chiefly into the speiss. These elements, in combination with the antimony, impart bad qualities to the copper, but it is much more convenient, therefore, to separate them from the copper by precipitating them in combination with the antimony than by driving them into the slags in the refining process of the copper.

The speiss of this melting has a grey colour, almost that of steel, the fracture is fine-grained, sometimes with traces of crystallisation. It is very brittle, and can easily be converted to the finest powder; red-hot in contact with the air it gives white fumes. The specific gravity differs but little from that of the mattee, therefore and because the mass runs with great rapidity through the crucibles, the speiss has no time to separate perfectly. The same contains, therefore, some matte mixed with it, which is visible in small particles. From it comes the sulphur, which is shown by the analysis. On the other hand, the mattee contains visible particles of speiss. From the above analysis it will be seen, and the results on a large scale prove it, that the speiss contains three times as much silver as the matte, produced at the same time. Formerly, before it was understood, how to amalgamate the speiss, the loss of silver was very great; now, the antimony has proved itself a conservator of the silver, the latter being no longer subjected to the losses, which are inevitable by the roasting of the matte, for the purpose of melting them to black copper. Besides that, the silver is gained three months sooner than when obtained from the black copper.

First or Crude Matte (*Rohlech*).—Bredberg determined the amount of sulphur in the matte (Rohlechs) to 26 per cent., which accords with the above. (The same is the case with the matte of the Phönixhuette.) Results quite different from these are given by Le Play in his examinations of the Swansea melting processes. The amount of copper, too, is far less than in the matte of the English melting works. In Hungary they fear to lose copper, if the first matte contains more than 25 per cent. of this metal. The matte of the Stefanshuette forms a mass, with a great many blisters, of steel-grey to violet colour; because it gets solid in the sump. In a pretty thin layer it is easily broken to pieces. I made a great many trials to ascertain the amount of antimony in the matte. By the roasting of these mattes an immense quantity of white smoke emanates from the heaps, which is so dense that it is impossible to see through it. In the night this smoke is seen from a distance of some miles as a fiery cloud. By seeing this great quantity of smoke, and considering that the produced black copper contains yet 8 to 13 per cent. of antimony, the quantity of 3·58 per cent. of antimony seems too small; but notwithstanding there are not less than 126,000lb of antimony in the 3,500,000lbs. of matte, produced during a year. Of these are found 34,000lbs. in the black copper (400,000 lbs. with 8·5 per cent Sb,) so that 92,000 lbs. of antimony pass into the air by the roasting of the matte and the melting for black copper. The 400,000 lbs of antimony contained in the ores, which are smelted during a year, are distributed as follows:—

	Pounds.		Pounds.
Lost by the first melting	600,000	Annual production of—	
Contained in the crude speiss	190,000	Speiss	300,000
„ slag	24,000	Slag	3,000,000
„ matte	126,000	Matte	3,500,000
	400,000		

Crude Slag from the Melting for Matte (*Rohschlacke*).—The crude slag of the Stefanshuette was in former times of a pale, stony aspect, contained visible quartz pieces and interspersed grains of matte. It was very imperfectly decomposed by chlorhydric acid. Since the addition of the pyrites was diminished, the visible quartz pieces have mostly disappeared, the colour of the slag became darker, and interspersed grains of matte are very rarely visible. The amount of SiO_3 in well melted pieces is fallen from 50 per cent. to 46·60 per cent.; yet this is more than that of the crude slag of the Phönixhuette, where the majority of the ores are quartzose.

This result is astonishing. The ores of the Stefanshütte contain only oxides as veinstone, and the quartzy ores are only added to remove these oxides in the form of slags. Now, where the acidity of the slags is known, the tendency is to diminish the quartzy additions, otherwise the diminution of the pyrites from 14 per cent. to 6 per cent. has rendered the slags more fusible, because a larger quantity of sparry iron can thereby be turned into slags. The same process could be observed here as by the formation of the Skumnas at Atvidaberg, in Sweden; in both cases, by the great amount of sulphur in the mixture, the slag was deprived of iron.

The melters, therefore, add much more Kupferrostschlacke (slag, obtained by melting roasted matte for the argentiferous black copper), if they can get it, than the above-mentioned 20 per cent. They further add limestone to increase the fusibility of the slag, wherefrom the presence of lime, shown by the analysis. The slag of the Stefanshuette could previously never be used for making slag bricks, which were needed in great quantities for building purposes and paving, and were brought from the Phœnixhuette; but now, since slags are produced containing less silica, and are therefore more easily fusible, and less stony, they can be used for slag bricks. The small amount of antimony in the crude slag is very remarkable, whilst it rises in the slag of the refining process to 20 per cent. By the crude melting a great portion of the antimony is volatilised, partly from the mouth, partly from the so-called "Lichtloch" (lighthole), an aperture of about 1in. diameter opposite the tuyeres, from where it bursts out with white flame, which at night is employed for lighting the works. According to my calculations, by the first melting about 600,000 lbs. of antimony escape to the atmosphere.

Methods of Analysis.—The analysis of all these antimonial products has great difficulties, because the decomposition by chlorine or the meeting with sulphide of potassium were not practicable for most of these products, containing small quantities of antimony, and which are often difficult to reduce to powder. I adhered to the method of dissolving them in fuming nitric acid; but hereby very often basic salts are formed, which cannot be decomposed by nitric acid, and which, when once dry, are insoluble in hydrochloric acid. Reischauer, of Munich, analysed such a substance remaining from the solution of copper, used by the coppersmiths of Munich, but does not mention the melting works, where the copper was produced. (Die Parasiten des Werk-kupfers, Oestr. Zeitschrift f. Berg und Hüttenw., 7 Nov., 1864.) He found it, after being dried over oil of vitriol,

SbO_5	66·61
PbO	10·91
CuO	7·97
SbO	2·28
NiO	2·17
FeO	1·66
HO	8·22
	99·82

I have not always obtained basic salts; from crude speiss and speiss resulting from the melting of refining slag always, but never from crude metallic antimony free of iron (see below). In general it seems they are formed when the solution goes on slowly, and if the substance to be dissolved is in excess of the solvent. This residue, after slight glowing, I calculated as SbO_4, but I always examined it before the blow-pipe, and then made the necessary deductions. For that purpose I weighed a part of it, mixed it with cyanide of potassium, soda, and some borax glass, and melted it, enveloped in a cylinder of soda paper, before the blow-pipe, whereby iron, cobalt, and nickel could easily be recognised. It is possible, when cobalt and nickel are present in small quantities only, to estimate their quantity according to the intensity the borax beads obtained. The copper remains as a pure grain, and can be weighed exactly. Here the figures obtained by the analysis of the crude speiss (Rohspeise).

One gramme reduced to fine powder was dissolved in pure fuming nitric acid. The solution was diluted, and, after the residue was perfectly settled, filtered, and then washed, ignited, and weighed = 0·790 gramme = 63·667 per cent. of antimony. 0·0200 gramme of this residue gave 0·0025 grammes of copper = 0·987 per cent. This deducted from above remain 62·68 per cent. of antimony; of iron only a trace was present: of nickel a trace; cobalt could not be found in it, but in several samples of the speiss its presence was indicated to the extent of about 0·2 per cent., by borax beads before the blow-pipe.

(*To be Continued*).

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE SOURCE OF MUSCULAR POWER.

By Edward Frankland, Ph.D. F.R.S., Professor of Chemistry, R.I.

What is the source of muscular power? Twenty years ago, if this question had been asked, there were but few philosophers who would have hesitated to reply, "The source of muscular power is that peculiar force which is developed by living animals, and which we term the vital force;" but the progress of scientific discovery has rendered the view implied in such an answer so utterly untenable that, at the present moment, no one possessing any knowledge of physical science would venture to return such a reply. We now know that an animal, however high its organisation may be, can no more generate an amount of force capable of moving a grain of sand than a stone can fall upwards, or a locomotive drive a train without fuel. All that such an animal can do is to liberate that store of force, or potential energy, which is locked up in its food. It is the chemical change which food suffers in the body of an animal that liberates the previously pent-up forces of that food, which now make their appearance in the form of actual energy—as heat and mechanical motion.

From food, and food alone, comes the matter of which the animal body is built up; and from food alone come all the different kinds of physical force which an animal is capable of manifesting.

The two chief forms of force thus manifested are heat and muscular motion, or mechanical work, and these have been almost universally traced to two distinct sources—the heat to the oxidation of the food, and the mechanical work to the oxidation of the muscles.

This doctrine, first promulgated, the speaker believed, by Liebig, occupies a prominent position in that philosopher's justly celebrated "Chemico-Physiological Essays."

In his work entitled "Die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie, Braunschweig, 1842," Liebig says, "All experience teaches that there is only one source of mechanical power in the organism, and this source is the transformation of the living parts of the body into lifeless compounds. * * This transformation occurs in consequence of the combination of oxygen with the substance of the living parts of the body." And again, in his "Letters on Chemistry, 1851," p. 366, referring to these living parts of the body, he says, "All these organised tissues, all the parts which in any way manifest force in the body are derived from the albumen of blood; all the albumen of the blood is derived from the plastic or sanguineous constituents of the food, whether animal or vegetable. It is clear, therefore, that the plastic constituents of food, the ultimate source of which is the vegetable kingdom, are the conditions essential to all production or manifestation of force, to all those effects which the animal organism produces by means of its organs of sense, thought, and motion." And again, at page 374, he says, "The sulphurised and nitrogenous constituents of food determine the continuance of the manifestations of force; the non-nitrogenous serve to produce heat. The former are the builders of organs and organised structures, and the producers of force; the latter support the respiratory process, they are materials for respiration."

This doctrine has since been treated as an almost self-evident truth in most physiological text-books; it has been quite recently supported by Ranke;* and, in his lecture "On the Food of Man in relation to his Useful Work, 1865," Playfair says, page 37, "From the considerations which have preceded, we consider Liebig amply justified in viewing the non-nitrogenous portions of food as mere heat-givers. * * While we have been led to the conclusion that the transformation of the tissues is the source of dynamical power in the animal." At page 30 he also says, "I agree with Draper and others in considering the contraction of a muscle due to a disintegration of its particles, and its relaxation to their restoration. * * All these facts prove that transformation of the muscle through the agency of oxygen is the condition of muscular action." Finally, in a masterly review of the present relations of chemistry to animal life, published in March last,† Odling says, page 98, "Seeing, then, that muscular exertion is really dependent upon muscular oxidation, we have to consider what should be the products, and what the value of this oxidation." * * And again, page 103, "The slow oxidation of so much carbon and hydrogen in the human body, therefore, will always produce its due amount of heat, or an equivalent in some other form of energy; for while the latent force liberated by the combustion of the carbon and hydrogen of fat is expressed solely in the form of heat, the combustion of an equal quantity of the carbon and hydrogen of voluntary muscle is expressed chiefly in the form of motion."

Nevertheless, this view of the origin of muscular power has not escaped challenge. Immediately after its first promulgation, Dr. J. R. Mayer wrote,‡ "A muscle is only an apparatus by means of which the transformation of force is effected, but it is not the material by the chemical change of which mechanical work is produced." He showed that the 15lbs. of dry muscles of a man weighing 150lbs. would, if their mechanical work were due to their chemical change, be completely oxidised in eighty days, the heart itself in eight days, and the ventricles of the heart in two days and a half. After endeavouring to prove by physiological arguments that not one per cent. of the oxygen absorbed in the lungs could possibly come into contact with the substance of the muscles, Mayer says, "The fire-place in which this combustion goes on is the interior of the blood vessels, the blood, however—a slowly-burning liquid—is the oil in the flame of life. * * Just as a plant-leaf transforms a given mechanical effect, light, into another force, chemical difference, so does the muscle produce mechanical work at the cost of the chemical difference, consumed in its capillaries. Heat can neither replace the sun's rays for the plant, nor the chemical process in the animal: every act of motion in an animal is attended by the consumption of oxygen and the production of carbonic acid and water; every muscle to which atmospheric oxygen does not gain access ceases to perform its function."

But Mayer was not the first to conceive this view of muscular action. Nearly 200 years ago, a Bath physician, Dr. John Nayow,* distinctly stated that for the production of muscular motion two things are necessary—the conveyance of combustible substances to the muscle by the blood, and the access of oxygen by respiration. He concluded that the chief combustible substance so used was fat. A century before Priestly isolated oxygen, Mayow was aware of its existence in the air, in nitre, and in nitric acid; he knew that combustion is supported by the oxygen of the air, and that this gas is absorbed in the lungs by the blood, and is absolutely necessary for muscular activity.

For two decades this doctrine sank into oblivion; and it is only within the last two years that it has been again advanced, chiefly by Haidenhain,† Traude, and to a limited extent. by Donders.‡

Experimental evidence was, however, still wanted to give permanent vitality to the resuscitated doctrine; for although the laborious and remarkable investigations of Voit|| and of Edward Smith point§ unmistakeably in the direction of Mayow and Mayer's hypothesis, yet the results of these physiologists were not sufficiently conclusive to render the opposite view untenable. This want of data of a sufficiently conclusive character has been supplied by a happily conceived experiment undertaken by Fick and Wislicenus in the autumn of last year, and described in the "Philosophical Magazine," vol. xxxi., p. 485. In the application of these data, however, to the problem now under consideration, one important link was found to be wanting, viz., the amount of actual energy generated by the oxidation of a given weight of muscle in the human body. Fick and Wislicenus refer to this missing link in the following words:—"The question now arises what quantity of heat is generated when muscle is burnt to the products in which its constituent elements leave the human body through the lungs and kidneys? At present, unfortunately, there are not the experimental data required to give an accurate answer to this important question, for neither the heat of combustion of muscle nor of the nitrogenous residue (urea) of muscle is known." Owing to the want of these data, the numerical results of the experiment of Fick and Wislicenus are rendered less conclusive against the hypothesis of muscle combustion than they otherwise would have been made by Edward Smith, Haughton, Playfair, and others, are even liable to a total misinterpretation from the same cause.

The speaker stated that he had supplied this want by the calorimetrical determination of the actual energy evolved by the combustion of muscle and of urea in oxygen. Availing himself of these data he then proceeded to the consideration of the problem to be solved, the present condition of which be thus summed up:—It is agreed on all hands that muscular power is derived exclusively from the mutual chemical action of the food and atmospheric oxygen; but opinions differ as to whether that food must first be converted into the actual organized substance of the muscle, before its oxidation can give rise to mechanical force, or whether it is not also possible that muscular work may he derived from the oxidation of the food, which has only arrived at the condition of blood and not of organised muscular tissue.

The importance of this problem can scarcely be overrated; it is a corner-stone of the physiological edifice, and the key to the phenomena of the nutrition of animals. For its satisfactory solution the following data require to be determined:—

1st. The amount of force or actual energy generated by the oxidation of a given amount of muscle in the body.

2nd. The amount of mechanical force exerted by the muscles of the body during a given time.

3rd. The quantity of muscle oxidised in the body during the same time.

If the total amount of force involved in muscular action, as measured by the mechanical work performed, be greater than that which could possibly be generated by the quantity of muscle oxidised during the same time, it necessarily follows that the power of the muscle is not derived from the oxidation of their own substance.

As regards the first datum to be determined, it is necessary to agree upon some unit for the measurement of mechanical force. The unit most commonly adopted is that represented by the lifting of a kilogram weight to the height of one metre. The researches of Joule and Mayer have connected this standard unit with heat;—they prove that the force required to elevate this weight 425 times will, when converted into heat, raise the temperature of an equal weight of water 1° C. If this weight were let fall from a height of 425 metres, its collision with the earth would produce an amount of heat sufficient to raise the temperature of 1 kilogram of water 1° C. The same heating effect would also of course be produced by the fall of 425 kilograms through 1 metre. This standard of force is termed a *metrekilogram*;¶ and 425 metrekilograms are equal to that amount of heat which is necessary to raise the temperature of 1 kilogram of water through 1° C. If then it be found that the heat evolved by the combustion of a certain weight of charcoal, or muscle, for instance, raises the temperature of 1 kilogram of water through 1° C., this means, when translated into mechanical power, 425 metrekilograms. Again, if a man weighing 64 kilograms climbs to a height of 1,000 metres, the ascent of his body to this

* "Tetanus, eine Physiologische Studie." Leipzig. 1865.

† "Lectures on Animal Chemistry."

‡ "Die organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel," 1845.

* "De Motu musculari," 1681. Mayow was born in 1645, and died 1679.

† "Mechanische Leistung, Wærmeentwickelung und Stoffumsatz bei der Muskelthætigkeit," 1864.

‡ As this is passing through the press, the speaker has become aware that Messrs. Lawes and Gilbert advocated this doctrine in 1852, and repeatedly since; their opinions being founded upon experiments on the feeding of cattle.

|| "Untersuchungen über den Einfluss des Kochsalzes, des Kaffees und der Muskelbewegungen auf den Stoffwechsel," p. 150. Munich, 1860.

§ "Phil. Trans.," 1861, p. 747.

¶ I follow the example of the Registrar-General in abbreviating the French word *gramme* to gram.

height represents 64,000 metrekilograms of work; that is, the labour necessary to raise a kilogram weight to the height of 1 metre 64,000 times.

In order to estimate the amount of actual energy generated by the oxidation of a given amount of muscle in the body, it is necessary to determine, first, the amonnt of actual energy generated by the combustion of that amouut of muscle in oxygen, and then to deduct from the number thus obtained the amount of energy still remaining in the products of the oxidation of this quantity of muscle which leave the body. Of these products, urea and uric and hippuric acids are the only ones in appreciable quantity which still retaiu potential energy on leaving the body, and of these the two latter are excreted in snch small proportious that they may be cousidered as urea without iutroducing any material error into the results.

These determinations were made in Lewis Thompson's calorimeter, which consists of a copper tube to contain a mixture of chlorate of potash with the combustible substance, and which can be enclosed in a kind of diving-bell, also of copper, and so lowered to the bottom of a suitable vessel containing a known quantity (2 litres) of water. The determinations were made with this instrument in the following manner:—19·5 grams of chlorate of potash, to which about $\frac{1}{8}$th of peroxide of mauganese was added was intimately mixed with a known weight (generally about 2 grams) of the snbstance whose potential energy was to be determined, and the mixture being then placed in the copper tube above mentioned, a small piece of cotton thread previously steeped iu chlorate of potash and dried was inserted in the mixture. Tbe temperature of the water in the calorimeter was now carefully ascertained by a delicate thermometer; and the end of the cotton thread being ignited the tube with its coutents was placed in the copper bell and lowered to the bottom of the water. As soon as the combustion reached the mixture a stream of gases issned from numerous small openings at the lower edge of the bell and rose to the surface of the water—a height of about 10in.

At the termination of the deflagration, the water was allowed free access to the interior of the bell, by opening a stopcock connected with the bell by a small tube rising above the surface of the water in the calorimeter. The gases in the interior of the bell were thus displaced by the incumbent column of water, and by moving the bell up and down repeatedly a perfect equilibrium of temperature throughout the entire mass of water was quickly established. The temperature of the water was again carefully observed, and the difference between this and tbe previous observation determines the calorific power or potential energy, expressed as heat, of the substance consumed.

The value thus obtained, is however, obviously subject to the following corrections:—

1. The amount of heat absorbed by the calorimeter and apparatus employed, *to be added.*
2. The amount of heat carried away by the escaping gases, after issuing from the water, *to be added.*
3. The amount of heat due to the decomposition of the chlorate of potash employed, *to be deducted.*
4. The amount of heat equivalent to the work performed by the gases generated in overcoming the pressure of the atmosphere, *to be added.*

Although the errors due to these causes to some extent neutralise each other, there is still an outstanding balance of sufficient importance to require that the necessary corrections should be carefully attended to.

The amount of error from the first cause was once for all experimentally determined, and was added to the increase of temperature observed in each experiment.

The amount of heat carried away by the escapiug gases after issuing from the water may be divided into two items, viz.:—

a. The amount of heat rendered latent by the water which is carried off by the gases in the form of vapour.

b. The amount of heat carried off by these gases by reason of their temperature being above that of the water from which they issue.

It was ascertained that a stream of dry air when passed through tbe water of the calorimeter, at about the same rate and for the same period of time as the gaseous products of combustion, depressed the temperature of the water by only 0°·02 C.

By placing a delicate thermometer in the escaping gases, and another in the water, no appreciable difference of temperature could be observed. Both these items may therefore be neglected.

The two remaining corrections can be best considered together, since a single careful determination eliminates both. When a combustible substance is burnt in gaseous oxygen, the conditions are essentially different from those which obtain when the same substance is consumed at the expense of the combined or solid oxygen of chlorate of potash. Iu the first case tho products of combustion, when coolcd to the temperature of water in the calorimeter, occupy less space than the substances concerned in the combustion, and no part of the energy developed is therefore expended in external work, that is, in overcoming the pressure of the atmosphere. In the second case, both the combustible and the supporter of combustiou are in the solid condition, whilst a considerable proportion of the products of combustion are gases. The generation of the latter cannot take place without the performance of external work, for every cubic inch produced must obviously, in overcoming atmospheric pressure, perform an amount of work equivalent, in round numbers, to the lifting of a weight 15lbs. to the height of one inch. In performing this work the gases are cooled, and consequently less heat is communicated to the water of the calorimeter. Nevertheless, the loss of heat due to this cause is but small. Under the actual conditions of the experiments detailed below, its amount would only have increased the temperature of the water in the calorimeter by 0°·07 C. Even this slight error is entirely eliminated by the final correction which we have now to consider.

It is well known that the decomposition of chlorate of potash into chloride of potassium and free oxygen is attended with the evolution of heat. If a few grains of peroxide of manganese, or better, of peroxide of iron, be dropped into an ounce or two of fused chlorate of potash which is slowly disengaging oxygen, the evolution of gas immediately proceeds with great violence, and the mixture becomes visibly red hot, although the external application of heat be discontinued from the moment when the metallic peroxide is added. The latter remains unaltered at the close of the operation. It is thus obvious that chlorate of potash, on being decomposed, furnishes considerably more heat than that which is necessary to gasify the oxygen which it evolves. It was therefore necessary to determine the amount of heat thus evolved by the quantity of chlorate of potash (9·75 grams) mixed with one gram of the substance burnt in each of the following determinations. This was effected by the use of two copper tubes, the oue placed within the other. The interior tube was charged with a known weight of the same mixture of chlorate of potash and peroxide of manganese as that used for the subsequent experiments, whilst the annular space between the two tubes was filled with a combustible mixture of chlorate and spermaceti, the calorific value of which had been previously ascertained. The latter mixture was ignitcd in the calorimeter as before, and the heat generated during its combustion effected the complete decomposition of the chlorate in the interior cylinder, as was proved by a subseqnent examinatiou of the liquid in the calorimeter, which contained no traces of undecomposed chlorate. The following are the results of five experiments thus made, expressed in units of heat, the unit being equal to 1 gram of water raised through 1° C. of temperature:—

	Units of Heat.
1st experiment	340
2nd „	300
3rd „	375
4th „	438
5th „	438
	5)1891
Mean	378

This result was coufirmed by the following experiments:—

1. Starch was burnt, firstly, in a current of oxygen gas, and secondly, by admixture with chlorate of potash and peroxide of manganese.

Heat units furnished by oue gram of starch burnt with 2·75 grams chlorate of patash	4290
Heat units furnished by the same weight of starch burnt in a stream of oxygen gas..	3964
Difference..	326

2nd. Pheuylic alcohol was burnt with chlorate of potash, and the result compared with the calorific value of this substance as determiued by Favre and Silbermann.

Heat units furnished by one gram of phenylic alcohol burnt with 9·75 grams chlorate of potash	8183
Heat units furnished by one gram of phenylic alcohol when burnt with gaseous oxygen (Favre and Silbermann)	7842
Difference..	341

These three determiuations of the heat evolved by the decomposition of 9·75 grams of chlorate of potash, furnishing the numbers 378, 326, and 341, agree as closely as could be expected, when it is considered that all experimental errors are necessarily thrown upon the calorific value of the chlorate of potash.

The mean of the above five experimental numbers was, in all cases, deducted from the actual valnes read off in the following determinations.

It was ascertaiued by numerous trials that all the chlorate of potash was decomposed in the deflagrations, and that but mere traces of carbonic oxide were produced.

Joule's mechanical equivalent of heat was employed, *viz.* 1 kilogram of water raised 1° C. = 423 metrokilograms.

The following results were obtained:

Actual energy developed by one gram of each substance when burnt in oxygen.

Name of Substancc dried at 100° C.	Heat Units.					Metre-kilograms of force. (Mean.)
	1st Experiment.	2nd Experiment.	3rd Experimcnt.	4th Experiment.	Mcan.	
Beef Muscle purified by repeated washing with ether......	5,174	5,062	5,195	5,088	5,103	2,161
Purified Albumen...	5,009	4,987	....	...	4,998	2,117
Beef Fat	9,069	...	...	...	9,069	3,841
Hippuric Acid	5,330	5,437	...	...	5,383	2,280
Uric Acid	2,645	2,585	...	...	2,615	1,108
Urea*..................	2,121	2,302	2,207	2,197	2,206	934

It is evident that the above determination of the actual energy developed by the combustion of muscle in oxygen represents more than he amount of actual energy produced by the oxidation of muscle within the body, because, when muscle

* The speaker showed the combnstibility of urea by bnrning it upon asbestos in a jar of oxygen gas.

burns iu oxygen its carbon is couverted into carbonic acid, and its hydrogen into water; the nitrogen being, to a great extent, evolved in the elementary state; whereas, when muscle is most completely cousumed iu the body, the products are carbouic acid water and urea; the whole of the nitrogen passes out of the body as urea—a substauce which still retains a considerable amouut of poteutial energy. Dry muscle aud pure albumen yield, under these circumstances, almost exactly one-third of their weight of urea, and this fact, together with the above determination of the actual energy developed on the combustion of urea, enables us to deduce with certainty the amount of actual energy developed by muscle and albumen respectively when consumed in the human body. It is as follows:—

Actual energy developed by one gram of each substance when consumed in the body.

Name of substance dried at 100° C.	Heat units (Mean.)	Metrekilograms of force (Mean.)
Beef Musle purified by ether	4,368	1,848
Purified Albumen	4,263	1,803

We have thus ascertained the first of our three data, *viz.* the amount of force or actual energy generated by the oxidation of a given amount of muscle in the hody; and we now proceed to ascertaiu the second, *viz.* the amount of mechanical force exerted by the muscles of the hody during a given time. For this purpose we have only to avail ourselvcs of the details of Fick and Wislicenus's conclusive experiment already referred to, and which cousisted in the ascent of the Faulhorn in Switzerland from the lake of Brienz. This mountain cau be asceuded by a very steep path from Iseltwald, which was of course favourable for the experiment, and there is an hotel on the summit which allowed the experimenters to pass the following night under tolerably normal circumstances. The following is their own description aud estimate of the amount of work performed iu the ascent.*

"Let us now inquire how much work was really done by our muscles. One item necessary for the reply is already at hand, *viz.* the height of the summit of the Faulhorn above the level of the lake of Brienz multiplied hy the weight of the body; the former reckoned in metres, the latter iu kilograms. The weight of the body with the equipments (hat, clothes, stick) amounted to 66 kilograms in Fick's case, and 76 in Wislicenus's. The height of the Faulhorn above the level of the lake of Brienz is, according to trigonometric measurements, exactly 1,956 metres. Therefore Fick performed 129,096 and Wislicenus 148,656 metrekilograms of muscular work."

But in additiou to this measurable external work there is another item of force "which can be expressed in units of work; aud though its value cannot be quite accurately calculated, yet a tolerable approximation can be made. It consists of the force consumed in respiration and the heart's action. The work performed by the heart has been estimated, in a healthy full-grown man, at about 0·64 metrekilograms† for each systole. During the ascent, Fick's pulse was about 120 per minute. That gives for the 5·5 hours of the ascent an amount of work which may be estimated at 25,344 metrekilograms, eutirely employed in the maintenance of the circulation. No attempt has yet been madc to estimate the labour of respiration. One of us has shown, however, in the second edition of his "Medical Physics" (p. 206), that Donder's well-known investigations concerning the conditious of pressure in the cavity of the thorax give sufficient data for such an estimate. He has there shown that the amount of work performed in an inspiration of 600 cubic centims. may he rated at about 0·63 metrekilogram. Fick breathed during the ascent at an average rate of ahout 25 respirations per minute, which gives, according to this estimatiou, an amount of respiratory work for the whole ascent of 5,197 metrekilograms. If we add this and the number represeuting the work of the heart, to the external work performed by Fick, we obtain a total of 159,637 metrekilograms. If we suppose that Wislicenus's respiratory and circulatory work bore the same proportion to Fick's as his bodily weight did to Fick's, *i. e.* 7 : 6, we obtain from Wislicenus' amount of work, as far as it is possihle to calculate it, a total of 184,287 metrekilograms.

"Besides these estimated (and certainly not over-estimated) items there are several others which cannot be even approximately calculated, but the sum of which, if it could be obtained, would probably exceed even our present large total. We will try to give at least some sort of an account of them. It must first he remembered that in the steepest mountain path there are occasional level portions, or even descents. In traversing such places the muscles of the leg are exerted as they are in ascending, but the whole work performed is transformed back into heat. The same force-producing process, however, must be going on in the muscles as if work were being performed which did not undergo this transformation. In order to make this point yet clearer we may take iuto consideration that the whole work of the ascent, only existed temporarily as work. On the following day the result was reversed; our bodies approached the centre of the earth hy as much as they had receded from it the day before, and, in consequence, on the second day an amount of heat was liberated equal to the amount of work previously performed. The two parts of the action, which in this case were performed on two separate days, take place in walking on level grouud in the space of a footstep.

"Let us observe besides, that iu an ascent it is not only those muscles of the leg specially devoted to climbing which are exerted, the arms, head, and trunk are continually in motiou. For all these movements force-generating processes are necessary, the result of which cannot, however, figure in our total of work, but must appear entirely in the form of heat, since all the mechanical effects of these movements are immediately undone again. If we raise an arm, we immediately let it drop again, &c.

"There was besides a large portion of our muscular system employed during the ascent, which was performing no external work (uot eveu temporary work, or mechanical effects immediately reversed) but which cannot be employed without the same force-generating processes which render external work possible. As long as we hold the body in an upright position, individual groups of muscles (as, for instance, the muscles of the back, neck, &c.) must be maintained in a state of continual tetanus iu order to preveut the body from collapsiug. We may couceive of a tetanised muscle as holding up a weight which would immediately fall if the supply of actual energy were to cease. It is active but it performs no work, and therefore all the force produced is liberated iu the form of heat."

Thus the total amount of measured and estimable work performed in 5·5 hours in the experiments hefore us was 159,637 metrekilograms for Fick, and 184,287 metrekilograms for Wislicenus. This is our second datum.

The third, viz. the amount of muscle oxidised in the hody during the performance of this work has been carefully determined by the same experimenters, as well as the rate of muscle consumption before and after the ascent. For the details of these determinations the speaker referred his hearers to the Philosophical Magazine for 1866, vol. xxxi. page 488; but the following is a condensed summary of the results:—

ASCENT OF THE FAULHORN.

	Fick.	Wislicenus.
Amount of Nitrogeu secreted iu Uriue per hour before ascent	Gram. ·63	Gram. ·61
Weight of dry Muscle corresponding to Nitrogen	4·19	4·05
Amount of Nitrogen secreted per hour duriug asceut ...	·41	·39
Weight of dry Muscle correspouding to Nitrogeu	2·70	2·55
Amount of Nitrogen secreted per hour during six hours after the ascent	·40	·40
Weight of dry Muscle corresponding to Nitrogen	2·63	2·63
Amount of Nitrogcn secreted per hour during the following night	·45	·51
Weight of dry Muscle correspouding to Nitrogen	3·06	3·39
Total amount of Nitrogen secreted during asceut.........	3·31	3·13
Ditto during six hours after ascent	2·43	2·42
	5·74	5·55
Weight of dry Muscle correspouding to Nitrogen secreted — During asceut	20·98	20·89
Weight of dry Muscle correspouding to Nitrogen secreted — During six hours after ascent	16·19	16·11
	37·17	37·00

The result of these determinations add a new liuk to the chain of experimental evidence, that muscular exertion does not necessarily increase the excretiou of nitrogen through the urine. From mid-day before the ascent (August 29th, 1865) to the following evening at seven o'clock (August 30th) both gentlemeu abstained from all nitrogenous food. During these thirty-one hours they had notbiug in the way of solid food except starch, fat, and sugar. The two former were taken in the form of cakes. Starch was made up with water into a thin paste, which was then made into small cakes and fried witb plenty of fat. The sugar was taken dissolved in tea. In addition to this there was the sugar contained in the beer and wine, which were taken in quantities usual in mouutain excursions. It was douhtless owing to this absence from food containing nitrogen that the amount of this element secreted through the urine, declined tolerably regularly from the 29th of August till the evening of the 30th. Even in the night of the 30th to the 31st, in spite of the plentiful meal of albuminous food on the evening of the 30th, the secretion

* 'Phil. Mag.' vol. xxxi. p. 496, 1866.
† 0·43 is here assigned as the work of the left, and 0·21 as that of the right ventricle.

of nitrogen was less than on the preceding night. The reason of this is probably to be sought for in the circumstances that during the period of abstinence, the secretion of nitrogen was carried on at the expense of tissues, and now these tissues required reparation.

It is perhaps scarcely worthy of record that during the ascent neither of the experimenters perspired perceptibly, since it has been proved by Ranke that no appreciable amount of nitrogen leaves the system in the matter of perspiration; and as Thiry has also shown that no nitrogen is got rid of by respiration, it follows that in addition to the nitrogen contained in the urine, the only other mode of exit for this element is through the fæces. Now the proportion secreted through the fæces has been estimated by Ranke at about one-twelfth of that in the urine; but inasmuch as all experiments on the subject tend to show that this alvine nitrogen is, as voided, a constituent of un-oxidised compounds, that is, of compounds that have not yielded up their force, it has no claim upon our attention.

There is still another circumstance which requires to be taken into consideration before we proceed to apply our three data to the solution of the problem before us. It is this:—

Is it possible that at the termination of the ascent of the Faulhorn there might be a considerable quantity of the nitrogenous products of decomposition retained in the body? Considering the physiological effect of the retention of urea in the system, as exemplified whenever the secretion of urine is interrupted it is difficult to imagine the possibility of any considerable quantity of urea being retained in the system of a healthy man. It is, however, otherwise with creatin, another of the products of the metamorphosis of tissue; for it has been repeatedly shown that a muscle which has been hard worked contains more creatin than one that has been at rest. Thus the quantity of creatin contained in the heart of an ox was found to be ·14 per cent. (Gregory), and that in other ox-flesh only ·06 per cent. (Staedeler). Now the muscles which extend the leg in walking, and which do the essential work in ascending, have been estimated by Weber to weigh in both legs 5·8 kilograms, and if we assume that before the ascent these muscles contained ·06 per cent. of creatin, whilst after the ascent the per centage had increased to ·14 per cent., then the amount of creatin thus exceptionally retained would amount to 4·64 grams, which would be derived from 8·4 grams of muscle.

The speaker had been unable to determine the calorific effect of creatin, and consequently the actual energy developed by the transformation of muscle into creatin: for, although he was kindly furnished with an ample supply of this material by Dr. Ditmar, yet all attempts to burn it in the calorimeter were fruitless. Even when mixed in very small proportions with chlorate of potash and other combustibles of well known value, the mixture invariably exploded violently on ignition. Although actual determination thus fails us, there can be no doubt that the transformation of muscle into creatin and other non-nitrogenous products must be attended by the liberation of far less actual energy than its transformation into urea, carbonic acid, and water. To be convinced of this, it is only necessary to compare (under equal nitrogen value) the formulæ of the muscle, creatin, and urea, remembering at the same time that the nitrogen probably possesses no thermal value, and that each atom of oxygen destroys approximately the thermal effect of two atoms of hydrogen.

	Comparable formulæ.	Powerful or unburnt matter.
Muscle	$C_{24}\,H_{37}\,N_6\,O_7$	$C_{24}\,H_{23}$
Creatin	$C_8\,H_{18}\,N_6\,O_4$	$C_8\,H_{10}$
Urea	$C_3\,H_{12}\,N_6\,O_3$	$C_3\,H_6$

Thus it is evident that the amount of creatin exceptionally retained in the system could not greatly affect the result of the experiment as regards the possible amount of actual energy derivable from the metamorphosed tissues during the ascent; firstly, on account of the small quantity of creatin so retained, and, secondly, because creatin still contains about one-third of the potential energy of the muscle from which it is derived. But as this point cannot be experimentally demonstrated the speaker followed the example of Fick and Wislicenus, and made a very liberal allowance on this score. He allowed, as they had done, that the whole of the nitrogen secreted during the six hours after the ascent was exceptionally retained in the system as urea during the ascent. This is equivalent to an admission that the muscles of the legs contained at the end of the ascent eleven times as much creatin as was present in them before the ascent. In the above tabular statement of results provision has been made for this allowance by adding together, on the one hand, the amounts of nitrogen secreted during the ascent and six hours after it, and, on the other, the weights of dry muscle corresponding to these two amounts of nitrogen.

Having thus far cleared the ground, let us now compare the amount of measured and calculated work performed by each of the experimenters during the ascent of the Faulhorn, with the actual energy capable of being developed by the maximum amount of muscle that could have been consumed in their bodies, this amount being represented by the total quantity of nitrogen excreted in each case during the ascent and for six hours afterwards.

It is thus evident that the muscular power expended by these gentlemen in the ascent of the Faulhorn could not be exclusively derived from the oxidation, either of their muscles, or of other nitrogenous constituents of their bodies, since the maximum of power capable of being derived from this source even under very favourable assumptions is, in both cases, less than one-half of the work actually performed. But the deficiency becomes much greater if we take into consideration the fact, that the actual energy developed by oxidation or combustion cannot be wholly transformed into mechanical work. In the best constructed steam-engine for instance, only one-tenths of the actual energy developed by the burning fuel can be obtained in the form of mechanical power; and in case of man, Helmholtz estimates that not more than one-fifth of the actual energy developed in the body can be made to appear as external work.

	Fick.	Wislicenus.
	Grams.	Grams.
Weight of dry Muscle consumed............	37·17	37·00
	Metrekilograms.	Metrekilograms.
Actual energy capable of being produced by the consumption of 37·17 and 37·00 grams of dry Muscle in the body	68,690	68,376
Measured work performed in the ascent (external work)	129,096	148,656
Calculated circulatory and respiratory work performed during the ascent (internal work)..	30,541	35,631
Total ascertainable work performed...	159,637	184,287

The experiments of Haidenhain, however, show that, under favourable circumstances, a muscle may be made to yield in the shape of mechanical work as much as one-half of the actual energy developed within it, the remainder taking the form of heat. Taking then this highest estimate of the proportion of mechanical work capable of being got out of actual energy, it becomes necessary to multiply by two the above numbers representing the ascertainable work performed, in order to express the actual energy involved in the production of that work. We then get the following comparison of the actual energy capable of being developed by the amount of muscle consumed, with the actual energy necessary for the performance of the work executed in the ascent of the Faulhorn.

	Fick.	Wislicenus.
	Metrekilograms.	Metrekilograms.
Actual energy capable of being produced by Muscle metamorphosis..................	68,690	68,376
Actual energy expended in work performed	319,274	368,574

Thus taking the average of the two experiments, it is evident that scarcely one-fifth of the actual energy required for the work performed could be obtained from the amount of muscle consumed.

Interpreted in the same way, previous experiments of a like kind prove the same thing, though not quite so conclusively. To illustrate this I will here give a summary of three sets of experiments: the first, made by Dr. E. Smith, upon prisoners engaged in treadmill labour; the second, by the Rev. Dr. Haughton, upon military prisoners engaged in shot drill; and the third, adduced by Playfair and made upon pedestrians, piledrivers, men turning a winch, and other labourers.

TREADWHEEL EXPERIMENTS.

A treadwheel is a revolving drum with steps placed at distances of 8 inches, and the prisoners are required to turn the wheel downwards by stepping upwards. Four prisoners, designated below as A, B, C, and D, were employed in these experiments, and each worked upon the wheel in alternate quarters of an hour, resting in a sitting posture during the intervening quarters. The period of actual daily labour was $3\frac{1}{2}$ hours. The total ascent per hour 2,160 feet, or per day 1·432 mile. The following are the results:—

Treadwheel Work.—(E. SMITH.)

	Weight in Kilograms.	Ascent in Metres.	Days occupied in Ascent.	External work performed in Metrekilograms.	Total Nitrogen evolved.	Weight of dry Muscle corresponding to Nitrogen.
					Grams.	Grams.
A	47·6	23,0	10	1,096,942	171·3	1101·2
B	49	23,045	10	1,129,205	174·5	1121·7
C	55	20,741	9	1,140,755	168·0	1080·1
D	56	20,741	9	1,161,496	159·3	1024·3

In these experiments the measured work was performed in the short space of 3½ hours, whilst the nitrogen estimated was that voided in the shape of urea in 24 hours. It will, therefore, be necessary to add to the measured work, that calculated for respiration and circulation for the whole period of 24 hours. This amount of internal work was computed, from the estimates of Helmholtz and Fick, to be as follows:

Internal Work.—(Helmholtz and Fick.)

	Work performed.	Actual energy required.
	Metrekilograms.	Metrekilograms.
Circulation of the blood during 24 hours, at 75 pulsations per minute	69,120*	138,240
Respiration for 24 hours, at 12 respirations per minute	10,886	21,772
Statical activity of muscles	not determined	not determined
Peristaltic motion	" "	" "
	80,006	160,012

Taking this estimate for internal work, the average results of the treadwheel experiments may be thus expressed:

Treadwheel Work.

Average external work per man per day	119,605 mks.
Average nitrogen evolved per man per day	17·7 grams.
Weight of dry muscle corresponding to average nitrogen evolved per day	114 "
Actual energy producible by the consumption of 114 grams of dry muscle in the body	210,672 mks.
Average actual energy developed in the body of each man, viz.—	
External work 119,605 × 2 = 239,210 mks.	
Circulation 69,120 × 2 = 138,240 "	
Respiration 10,886 × 2 = 21,772 "	
	399,222 "

In these experiments the conditions were obviously very unfavourable for the comparison of the amount of actual energy producible from muscle metarmorphosis, with the quantity of actual energy expended in the performance of estimable work; siuce, during that portion of the tweuty-four hours not occupied in the actual experiment, a large amount of unestimable internal work, such as the statical activity of the muscles, peristaltic motion, &c., was being performed. Nevertheless, these experiments show that the average actual energy developed in producing work in the body of each man was nearly twice as great as that which could possibly be produced by the whole of the nitrogenous matter oxidised in the body during 24 hours. It must also be remarked that the prisoners were fed upon a uitrogenous diet containing six ounces of cooked meat, without bone; a diet which, as is well know, would favour the production of urea.

Shot-drill Experiments.

The men employed for these experiments were fed exclusively upon vegetable diet, and they consequeutly secreted a considerably smaller amount of nitrogen than the flesh-eaters engaged iu the treadwheel work. The other conditions were, however, equally unfavourable for showiug the excess of work performed, over the amount derivable from muscle metamorphosis.

In shot-drill, each man lifts a 32lb. shot from a tressel to his breast, a height of 3ft.; he then carries it a distauce of 9ft., and lays it down on a similar support, returning unloaded. Six of these double journeys occupy one minute. The men were daily engaged with—

Shot drill	3 hours.
Ordinary drill	1¼ "
Oakum picking	3½ "

The total average daily exterual work was estimated by Haughton at 96,316 metrekoligrams per man.

The following is a condensed summary of the results of these experiments:—

Military Vegetarian Prisoners at Shot Drill.—(Haughton.)

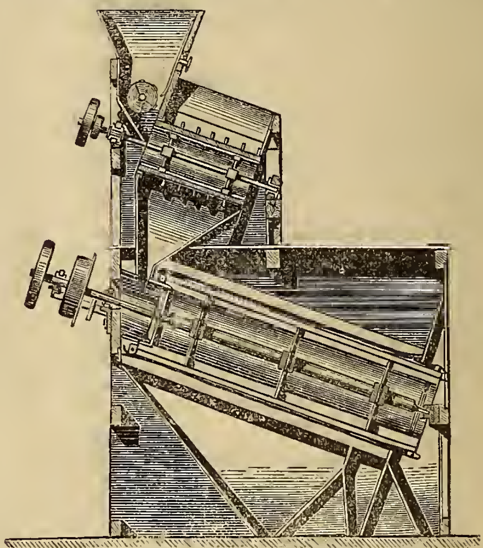
Average external work per man per day	96,316 mks.
Average nitrogen evolved per man per day	12·1 grams
Weight of dry muscle corresponding to average uitrogen evolved per day	77·9 "
Actual energy producible by the consumption of 77·9 grams of dry musle in the body	143,950 mks.
Average actual energy developed daily in the body of each man, viz., external work 96,316 × 2 = 192,632 mks.	
Iuternal work 160.012 "	
	352,644 mks.

* Since making use of this number, I find that Donders estimates the work of the heart alone, for 24 hours, at 86,000 metrekilograms, a figure which is higher than that above for the combined work of circulation and respiration.

Owing chiefly to the vegetable diet of these prisoners, the result is more conclusive than that obtained upon the treadwheel, the amount of work actnally performed being considerably more than twice as great as that which could possibly be obtained through the muscle metamorphosis occurring in the bodies of the prisoners.

(To be continued.)

SAVORY'S IMPROVED BOLTER FOR DRESSING FLOUR.



The distinctive features of this invention, recently patented by Mr. W. Savory, of Gloucester, consist in the continuity of the process and greater completeness of the separation of the various kinds of the products derived from the grinding of corn—flour, meal, offal, &c. As the illustration shows, the cereals, as they come from the mill proper, pass into the upper hopper, and descend to the separating apparatus in which the bran, &c., is entirely removed; thence they pass to the holter-cloth, fitted on to the arms of a revolving reel, and, the finest flour only passing through the cloth, will thence fall into the shoot appropriated for it, while other shoots receive the various other kinds of produce—such as meal, offal, &c. The arrangement of these bolters is such as to keep the cloth clear of the meaner sorts, so that nothing but a complete separation of meal and flour is effected through the holter-cloth itself. The bolter-cloth is reversible, and the peculiar manner in which it is used and fitted to the reel, as indicated in our illustration, constitutes the chief merit of Mr. Savory's contrivance. The general conditions under which this bolter works are more favourable than those of other similar apparatus: the wear and tear is reduced, and the useful effect increased. The appliances, as shown in our illustration, can be readily fitted to existing bolters.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

To the Editor of The Artizan.

Sir,—If the doctrine of continuity, as propounded by Mr. Grove in his address to the meeting of the British Association, be carried to its ultimate logical conclusions, in so far as it refers to the origin and propagation of species, it teaches that the higher representatives of organic nature are but the remote offspring of the simplest and most elementary organism which it is possible to conceive of, that man, in fact, is but a highly developed grub.

The proposition certainly is not presented to us in Mr. Grove's address with that unshrouded clearness of language in which we have clothed it. Indeed, we find here a good deal of matter, consisting of a number of facts interesting in themselves, as indicating variety in form, accompanied by similarity of habits and circumstances, though to our mind inadequate in their scope, and too much disjointed to effectually support the principles which it is sought to establish, namely, the absence of any fixed species, and the non-occurrence of spontaneous creations. But the whole of this is interspersed with a number of

sentences, some of which, when placed into juxtaposition, present this (not entirely new) creed in wording almost identical with our own. Thus in one place Mr. Grove asks, "Are there any species, or are there not?" and in subsequent paragraphs he endeavours to answer the question in the negative by saying that "the more we observe, the more we increase the subdivision of species, and consequently the number of these supposed creations, of which, however, we have no well-authenticated instance;" further on, again, he says, "To suppose a zoophite the progenitor of a mammal would appear at first sight an extravagant hypothesis;" and in the same sentence he adds that "it would be equally extravagant to suppose a highly developed animal to have come out of nothing, or to have suddenly grown out of inorganic matter," which several sentences may be consecutively rendered as follows, without material alteration in the wording:—

"It is extravagant to suppose that highly developed animals have suddenly grown out of nothing or out of inorganic matter, because there are no autheuticated instances of spontaneous ereations; seeing, also, how species hitherto supposed distinct are now found to have common characteristics, the inference is tbat there is no such thing as distinct and fixed species, but that all animals including the most perfect are the offspring of one and the same agent of generation—a zoophite or other elementary organism.

"Whence came this elephant," exclaims Mr. Grove as, proceeding with his address, he enters upon the subject of the origin of species; "Did he fall from tbe sky? Did he rise moulded out of a mass of amorphous earth, or did he appear out of the cleft of a tree? For if he had no antecedent progenitor, some such beginning must be assigned to him;" and to the auswer that he came to be because God willed it, he replies that such answer is unphilosophical. It might here at once be asked, hy way of reply, why does Mr. Grove instance tbe elephaut as an unlikely subject for spontaneous creation rather than *man*, admittedly the most perfect of all created beings, and the critic might not without some reason draw from this selection the inference that, in Mr. Grove's opinion, the ponderous mass of the elephant is a thing more difficult to fashion and instantaueously to briug into life than the more modest proportions of tbe frame of man, more particularly as the same idea pervades the whole of this portion of his address; thus we find that in one of the opening paragraphs of this part of it, he says:—"As we have long ceased to expect to find a Plesiausaurus spontaneously generated in our fish-pouds, or a Pierodactyle in our pheasant covers; the field of this class of research has become identified with the field of the microscope, and at each new phase the investigation has passed from larger to smaller organisms;" and again, towards the close of his address, he exclaims:—"Who would not be astonished at beholding an oak tree spring up in a day;" all which quotations clearly sbow that the spontaneous creation of a ponderous liviug mass is a notion especially repugnant to Mr. Grove's mind. This admission might again draw from us the following question in reply: why do you think it morc difficult to hreathe the breath of life into a conglomeration of atoms than into a single atom? but such a mode of procedure, hy stifling all argument, on the subject at the very outset would not tend to the elucidation of truth, and since *philosophy* simply means iu plain English, *the love of truth*, let us endeavour in this criticism to be philosophical.

Now all philosophical inquiry, or search after truth, must have for its groundwork certain primary truths or axioms, which admit of no proof but which are evident of themselvss and auything opposed to which would be repugnant to the human understanding; thus the whole structure of the science of dynamics is grounded upon the axiom first laid down hy Newton, that "re-action is equal and opposed to action;" the science of mensuration and of numbers upon the axiom that "two quantities equal to a third are equal to each other;" and in the study of those sciences any argument which loses sight of those primary truths must lead to erroneous conclusions; such also is the case in the study of metaphysics—psychology, ethics, and theology—although in these studies which deal with pure abstractions it is more difficult to avoid crror than in the prosecution of either mathematical or experimental truth.

In like manner must the study of the origin and propagation of species, which forms a branch of experimental science, proceed from one or more primary truths, to serve as ground-work for inquiry iuto all questions relating thereto, and the axioms upon which Mr. Grove's conclusions are based appear in substance to be as follows:—

1st. All organisms receive their life and being from similar organisms previously extant, by the ordinary process of generation.

2nd. Life adapts its material envelope by a natural and self-acting process to the particular circumstauces under which it is called into existence.

Mr. Grove, it is truc, has not presented his subject in the unadorned and unattractive shape of a syllogism, hut just as the conclusions to which his essay tends heve becn picked out of its voluminous matter, in the same manner may the premises from which he proceeds or the axioms upon which they are grounded be placed in evidence; thus, the first of these two axioms is clearly embodied in the following sentences:—

"As we detect no such phonomena as *the creation or spontaneous generation* of vegetables and animals which are large enough for the eyes to see," and "see no such phenomena as the formation of an animal such as an elephant or a tree, such as an oak, excepting from a parent which resembles it, the balance of opinion is against spontaneous generation."

And the second axiom is as clearly embodied in the following statements:—

"If an animal seeks its food or safety by climbing trees, its claws become more prehensible; the muscles which act upon those claws must become more developed, and the body will become agile hy the very exercise which is necessary to it, and each portion of the frame will mould itself to the wants of the animal by the effects on it of the habits of the animal. If we are satisfied that organic forms have varied indefinitively in time; if we assume that the struggle for existence coupled with the tendency of like to produce like give rise to various organic changes, still our researches are at present uninstructive as to why acquired characteristics in the parent should be reproduced in the offspring."

Accepting now the validity of these two axioms it follows as a matter of necessity that the most perfect of all organisms may he or should be considered as the offspring of a less perfect one, differing from the former in a small degree only, aud assuming also that such changes have heen going on through countless ages as a necessary result of varying conditions of climate, atmosphere, and means of subsisteuce, it follows further that the various species of beings with which we are acquainted, originate all from one or a few elemeutary organisms.

Looking upon the question from a physiological point of view only, there is so far nothing repugnant to human reason in these conclusions; change and mutation are but the order of the day of human life, and infinitesimal changes are more acceptable to the buman mind than extensive and sudden transformations, while, on the other hand, it is quite possible and easy to conceive that the assumed property of organic matter to adapt itself to altered conditions of existence is co-existent with matter and with the organic world. That the effects upon tbe animal, of coutracted habits in the parent, the consequences either of taste or neceesity should be reproduced in the offspring aud constitute henceforward a more or less permanent characteristic of his frame and being, is a phenomenon with which we are all familiar, in so far at any rate as it applies to wbat is termed temperament and constitution, either pbysical or mental. In proof of this we need but point to that hereditary disease, the gout, or to idiotcy, and though in the case of man we have no record of auy great organic change—though it has not heen the good fortune of any one of us to be horn with wings, because his forefathers for many generations past may have attempted to fly, this negative testimony, in presence of thc positive knowledge we have of the plasticity of organic matter, is uot necessarily conclusive evideuce against the proposition that in remote ages past man may have grown to his present comparatively perfect condition out of a less perfect organism.

Arrived at this stage, however, of our inquiry, where all orgauic nature is supposed to have heen traced to a common parent, the subject becomes more difficult; for it will now he necessary to show how tbis elemeutary organism came by its life and being.

The question, therefore, which now presents itself is identical with tbe one thrown out hy Mr. Grove in introducing tbis subject. He asks, "How came this elephant to be?" and reasoniug from his own premises, we are now compelled to ask, "How came this element to be?" both which questions resolve themselves into the following, viz.: "How came the principle of life to be introduced into matter?"

Those who refuse to recognise all miraculous or spontaneous manifestation of the creative power of God, but would rather suhmit everything to the test and scrutiny of human reason, will no doubt answer the questiou in the following manner:—"It is admitted that organic matter will adapt itself, by its own inherent power, to different conditions of existence. Why, then, should not inorganic matter possess the faculty of springing up into elementary life under certain peculiar, though to us unknown, circumstances?" So far, at any rate, as we can see, this is the only method to dispose of this difficulty; and though Mr. Grove has eluded, or has avoided openly to grapple with it, yet is there ample evidence in his disconrse to show that he entertains favourahly such a solution of the question, as will be seen in the following:—"If," says he, "we now assign to the heat of the sun an action enahling vegetables to live by assimilating gases and amorphous earths iuto growing structures, why should such effects not have taken place in earlier periods of the world's history, when the sun shone as now, and when the same materials existed for its rays to fall upon?" Tbis is a statement which, though it does not amount to a positive affirmation, gives fair ground for inference that Mr. Grove attributes primarily to the action of the sun the wonder-

ful phenomenon of life, hitherto unaccounted for upon what we term natural grounds.

Accepting, however, for a moment this postulate as a valid solution of the question raised by ourselves, let us see to what consequences it will lead.

In the first place it is directly at variance with one of the two axioms upon which Mr. Grove's conclusions are grounded—namely, the one that "all organisms receive their being from similar organisms, previously extant, by the ordinary process of generation"—a flagrant contradiction sufficient of itself to overthrow the whole of this system of natural philosophy, which endeavours to divest the fact of creation of the active, though mysterious agency of Providence.

In the second place, while it leads to that egotistical pantheism which makes of matter its own God, while it robs human life of all its poetry by lowering man to the rank of a mere intellectual brute, it fails to remove that very obstacle which is so great an eye-sore to Mr. Grove—namely, the spontaneous appearance of life out of matter hitherto inert. The attempt which is made to lessen the difficulty by referring the whole of organic nature to the most elementary organism conceivable is a total failure, because the difference between inert matter and living and still more sentient matter is so great—the gulf, in fact, between death and life is so wide—that it seems childish to doubt but that the power which is able to bridge the same is equally capable to create that accomplished being, man, that ponderous living mass the elephant, or the worm that feeds upon their carcasses.

Independently of the difficulty into which we have been landed by following out Mr. Grove's line of argument, another one presents itself to our mind not easily disposed of. We apprehend namely that it is a fair question to put to the advocate of continuity, "How do you account for the stubborn fixity of the attributes and characteristics of man during the whole of the historical period now extending over the not insignificant space of 6,000 years? for if there be such a law of organic matter as continuity in progression, it is not unreasonable to suggest that the great and continuous efforts which the human race is known to have made in the acquisition of knowledge and in the melioration of its material condition, ought to have produced some perceptible change either in the the physical or the mental constitution of man. The works, however, of the ancients either in art or in science, and even the more recently discovered relics of prehistorial man point to the same kind of ingenuity or spirit of invention, and later to the same spirit of research and the same refinement of ideas as man is known to possess now; in his frame, also, he has remained unchanged, and, although we have said in a previous paragraph that this apparent fixity is not necessarily conclusive evidence against the doctrine of continuity, yet it is fair to ask for an explanation of this fact, more especially so as Mr. Grove states in his address that "Mr. Bates, when investigating the Lepidoptera of the Amazon valley, may almost be said to have witnessed the origin of some species of butterflies, so close have his observations on the habits of these animals that have led to their variation and segregation."

The formation of species in the genus butterfly may be considerably more rapid than in the genus man, but it requires to be explained why there should be absolute fixity in the one case, while in the other there is such rapid change.

We shall conclude our critique by observing that in our opinion the advocates of continuity err, because they endeavour to explain that which admits of no explanation; they either want to prove or are driven to the necessity of proving why or how the principle of life was infused into matter, and as in physical science all proof must rest upon something antecedent, they are thus necessarily carried beyond the fact of creation where the ground disappears from under their feet and there is no foundation to rest such proof upon but the assumption of the previous existence of a transcendental power, *i.e.*, of Eternal God.

J. J. Birckel.

Obituary.

MR. BENJAMIN HALL BLYTH, C.E.

Mr. Benjamin Hall Blyth, C.E., of the firm of B. and E. Blyth, George-street, and engineer of the Caledonian Railway Company, died on Tuesday morning, August 28th, after a lingering illness, at North Berwick, where he had been residing for some weeks past. Mr. Blyth, who has latterly obtained considerable repute as a railway engineer, and has been very successful in his schemes, took an active part in the recent Parliamentary contests between the Caledonian and North British Railway Companies, and was very serviceable to his company. For two or three years past he has been the victim of an insidious and lingering disease, of which the melancholy end was but too certain; and on the close of the Parliamentary campaign he was ordered home by his physician, and forbidden to distract his mind by the cares of business. For several weeks he has been residing at North Berwick; but the relief from the harassing cares of his profession, and all the aid of the best professional skill, came too late to save his life. Mr. Blyth was a native of Edinburgh, the son of an Englishman settled in that city—the late Mr. R. Blyth. Though comparatively a young man, being only forty-seven at his death, Mr. Blyth was exceedingly able in his profession, especially as a Parliamentary witness. He had an extensive railway connection, having been formerly employed by the Glasgow and South-Western Railway and other companies. Mr. Blyth laid out the Great North of Scotland Railway, and other railways in the north, and latterly, of course, was actively engaged in the numerous schemes which have been prosecuted by the Caledonian Company. As a citizen he was much respected, and by his friends dearly beloved.

REVIEWS AND NOTICES OF NEW BOOKS.

The Uptonian Trisection. Respectfully dedicated to the Schoolmasters of the United Kingdom. London: E. ant F. N. Spon, Bucklersbury. 1866.

This is a pamphlet consisting of twenty pages of letter-press and three plates; the preface extends from pages 3 to 9, the appendix from pages 13 to 20. The pith and substance itself, contained in pages 10 to 13, purports to show a purely geometrical method of trisecting any angle. The preliminary proposition on which this method is based, is unexceptionable, and its application perfectly sound; in practice, however, it will very seldom be found expedient to resort to this method, the result obtained being inadequate to the trouble involved by its complication. On paper, the fact that in small angles the sine is as near as possible equal to the arc, will always facilitate an approximate trisection, the inaccuracy of which is imperceptible to the naked eye; in the field, the usual trigonometrical methods cannot be deviated from. Still we may be allowed to say that full credit is due to the author for the pains he has taken, although the novelty of his method is questionable and his εὕρηκα premature: *amicus Plato* (not *Cato*, as the author has it), *sed magis amica veritas.* However, his little work is a very useful contribution to the literature of mathematics.

Sulle Bonificazioni, Risaie ed Irrigazioni del Regno d' Italia. Relazione a S. E. il Ministro di Agricoltura, Industria e Commercio. (Luigi Torelli). Milano: Tipografia e Litografia degli Ingegneri. 1865. (Report on the Reclamation of land, rice fields, and irrigation of the Kingdom of Italy).

This valuable publication, issued by order of the Minister of Agriculture, Industry, and Commerce of the Kingdom of Italy, gives an account of the labours performed in the fifty-nine provinces of the Peninsula and the adjacent islands of Sardinia and Sicily, inaugurated in 1862 under the auspices of the then Minister of Agriculture, Marquis Pepoli, with a view to ameliorate the soil of the country in general and reclaim a large area of marshy ground, by means of an elaborate system of drainage, sewerage, and irrigations. Much commendation is due to our worthy *confrère*, Marquis Raffaele Pareto (the editor of the *Giornale dell' Ingegnere ed Architetto*), for the very creditable manner in which the work under notice was prepared by him. The literature of engineering has been, hitherto, rather sterile in the new-born kingdom; we therefore hail with delight any new publication tending to enhance the development and give an additional impulse to the cultivation of the engineering science in that country. The present "relazione," in its *ensemble* is an excellent digest of the most noteworthy facts and figures connected with drainage and irrigation, as far as Italy is concerned; and we recommend a careful perusal and study of this work to those members of the profession whose pursuits cause them to take a special interest in this branch. Our space being too limited, we are not permitted to do full justice to Signor Pareto's compilation; but in a future number we shall reproduce from it a table of the areas covered by marshes, rice fields, lakes, &c. in each of the present provinces of the Italian kingdom.

The Management of Steel.—By George Ede, London. William Tweedie, 337, Strand.

Mr. Ede's work supplies a want which was long felt by practical mechanics, and all engaged in the manipulation of iron and steel. We are glad to find the book is so well appreciated as to have already reached a fourth edition. We cordially endorse the words used by Mr. Ede in his preface, in which he states if young apprentices were taught to make themselves better acquainted with the materials they work upon, likewise the materials from which their tools are made, and the management of

that material, the advancement of the sciences would be greatly hastened, as this knowledge would increase the powers of the head to contrive, and the hands to execute. The inventions which become publicly known are few in comparison with those which spring up in the minds of ingenious mechanics, and perish with the hour that gave them birth, through the want of a better knowledge of the properties of materials.

We wish the work continued success; it should be in the hands of every intelligent mechanic.

A Record of the Progress of Modern Engineering. Edited by William Humber, E.C. London: Lockwood and Co., Stationer's-hall-court. 1866.

Mr. Humber is so well known as a most industrious collator of engineering information that it is scarcely necessary for us to do more than state that upon the present occasion he has been more than usually successful in the selection of subjects chosen for illustration in the record of modern engineering for 1865. In bridges and girders, railway-station and other roofs, and works of construction of a kindred character Mr. Humber has long been known as most enterprising and successful in the literary labours of a scientific recorder of progress in engineering science; and when he adopted the present form, he made a wise and judicious change in the style, as well as the annual character he gave to the publication, enabling him, as it evidently has done, to do more ample justice to his subjects, by making the illustrations more comprehensive and complete.

Amongst the subjects illustrated in the present volume is a very complete series relating to the great works now in progress—the Thames Embankment works and the Metropolitan Main Drainage. These are amply described by the textual matter in the body of the work. There are some excellent papers on the construction of harbours, ports, and breakwaters; on the *rationale* of railway rolling stock; the *rationale* of the sewage system; the history of the drainage and sewage of London; and there is a very good paper originally published by Mr. Alex. Doull, C.E., on an improved system of fortification; and the subject of granite and iron forts is shortly, but usefully treated.

This year Mr. Humber has given a biographical sketch of J. R. McLean, Esq., F.A.S., F.G.S., the immediate past President of the Institution of Civil Engineers, and a splendid life-like portrait of that gentleman, photographed in Wothlytype.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Sept. 1.			Sept. 8.			Sept. 15.			Sept. 22.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	80	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	81	0	0	86	0	0	86	0	0	88	0	0
Copper wire, per lb.	0	0	11½	0	0	11¾	0	0	11¾	0	0	11¾
„ tubes, do.	0	1	0	0	1	0¼	0	1	0¼	0	1	0¼
Sheathing, per ton	86	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	91	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	6	15	0	6	15	0	7	2	6	7	2	6
Nail rods, do.	7	10	0	7	10	0	7	10	0	7	10	0
„ Stafford in London, do.	8	10	0	8	10	0	8	10	0	8	10	0
Bars, do.	8	10	0	8	10	0	8	10	0	8	10	0
Hoops, do.	9	5	0	9	5	0	9	5	0	9	5	0
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	13	3	2	16	6	2	15	6	2	15	6
LEAD.												
English pig, ord. soft, per ton	19	15	0	20	7	6	20	7	6	20	5	0
„ sheet, do.	21	10	0	21	10	0	21	10	0	21	10	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	5	0	19	5	0	19	5	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	9	0	0	10¼	0	0	10¼	0	0	10¼
Wire, do.	0	0	8¾	0	0	9¾	0	0	9¾	0	0	9½
Tubes, do.	0	0	9¼	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	8	6	1	10	0	1	10	0	1	14	0
IX „ „ „	1	14	6	1	16	0	1	16	0	2	0	0
IC „ 2nd qua., „	1	6	6	1	8	0	1	8	0	1	10	0
IC Coke, per box	1	3	0	1	3	6	1	4	0	1	4	0
IX „ „	1	9	0	1	9	6	1	10	0	1	10	0

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The North Staffordshire Steel, Iron, and Coal Company, Burslem (Limited), v. Lord Camoys.—Vice-Chancellor Sir R. T. Kindersley delivered judgment on the 28th inst., in this case, which was heard some time since. The bill is filed to restrain the defendant, as lessor of the Upper and Lower Grange Mines, on the Rushton Grange estate, near Burslem, from proceeding in an action of ejectment on an alleged forfeiture of the lease, chiefly on the ground of a mode of working both as to mode and time, inconsistent with the covenant, and his lordship's agent, Mr. Bute, and Mr. Martin, the original lessee under Lord Camoys, from whom the plaintiffs took, were examined *viva voce* in Court upon these points. His Honour entered into a most minute consideration of the facts and arguments, observing that the grounds as to the frost and substitution were in fact not argued. There had been two breaches at law—one by the non-erection of the powerful engine and sinking the two main shafts, the other as to the sinking the shafts within the 100yds. radius. It was admitted, and the contrary could not be argued, that if a covenantee stands by and permits the covenantor to spend money, although he knows that the covenant is not being performed, that alone was not a sufficient ground for the interference of the Court of Equity. But if Mr. Bute negotiated with the company at a time when he knew the covenant could not be performed this Court would interfere. The fact depended on the evidence, and between that of Mr. Martin and Mr. Bute there was considerable conflict as to erection of the engine and engine-house, one fixing two months, the others nine, ten, or twelve months; but his Honour would assume that an engine could be purchased ready, and therefore the real question was the fixing and the building of the engine-house. No doubt, as to the discrepancy of time, the truth was between the two, and the explanation as to why it was not commenced, knowing it would take so long, was that the power was not determined upon. Of course, if there was no other, that was no excuse for the breach. No doubt the company were guilty of great fault and omission, and almost wilfully violated their covenant, but, the question being whether Mr. Bute had encouraged them to go on and spend money, knowing that the covenant could not be performed, his Honour thought that he had, in the sense that, knowing the impossibility, the breach would not be taken advantage of. Between the 6th of January and the 25th of March, on the evidence, it could not be done, and therefore, on that question, the plaintiffs were entitled to the injunction. It was said that Mr. Bute had no authority to waive a covenant. No doubt he had not; but he could negotiate for leases, and he did so on the footing of an existing lease, and therefore that came to the same thing. As to the other breach, of sinking within 100yds. radius, that was clear, and the only question was whether Mr. Bute knew of it. His Honour thought he did not, and therefore that was sufficient to disentitle the plaintiffs to relief, and as judgment had been recovered in this action the bill must be discharged without costs, and the execution would issue. Mr. Glasse then asked to stay execution, pending an appeal. His Honour ultimately gave till the second day of Hilary Term, 1867, without prejudice to any application by Lord Camoys with respect to the plaintiffs' undertaking as to damages, with liberty to apply. He hoped the parties would come to some arrangement. Some arrangement was also made as to paying the arrears of rent.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Coal Gas.—During the distillation of coal, or cannel, is manufacture of gas, Mr. Swindells, of Wigan, admits superheated steam into the retorts among the charge, by so doing the bisulphate of carbon, liberated during the distillatory process, is decomposed and carried forward by the gas to the purifiers in a condition for which ordinary purifying agents have great affinity. The quantity of steam is increased as required.

Shooting Stars.—In a lecture at the Royal Institution on the shooting-stars of the years 1865-6, Mr. Alexander Herschel has attempted to show that they have periodical returns like comets, and in support of this position he referred to the records of observations made from time to time during the last 1,000 years. Observations show that during every clear night in this hemisphere, shooting-stars may be seen, the ordinary number being about thirty an hour; but that in certain months, especially in the beginning of November, the number of these stars is greatly increased. It appears also that at intervals of thirty-three years there have been noticed very remarkable showers of shooting-stars. One of these periods will occur about the 13th of November next.

American Eloquence.—All who have enjoyed an intercourse with Americans, admit their eloquence to be unique. Their command of facts, and description of them is so ingenious, that you must be "dreadful cute," if you discover the line between the facts and the *invention* due to the ornamentation of their ingenious description. When they do the scientific, then their corruscations of genius supplies the want of knowledge of facts, and produce pleasurable effects, as intended, in the uninitiated, leaving the minority

to grieve, if they think proper. Such reflections result from a perusal of their "scientific papers," which are deeply imbued with this kind of genius of invention. An article headed "Sodium Amalgam," has much amused its readers. There a reference to, and and description of, is blended in an explanation of the amalgam, so that a halo of confusion, or of admiration of the dexterity of the performer, is very likely to pervade the mind of the uninformed reader. To reach the understanding of such readers, the writer illustrates his meaning in a few graphic touches. "A very little sodium makes a solid amalgam" [alone it makes nothing of the kind] but 1 part sodium to 50 parts mercury, gives a consistency of butter, 1 sodium to 30 mercury gives a solid, not so tough, but otherwise much resembling zinc." If that should fail to carry the requisite amount of knowledge we learn *the effects* of the sodium-amalgam in such convincing language as this: "Whenever sodium amalgam touches gold, it sticks to it, and does let it go; it sticketh like a broker; to gold and silver it as adhesive as tar to a contraband." Such scientific writing cannot be dry reading, when it makes the reader laugh. There is here, after all, an interesting redeeming sense of justice which also we extract, thus: "Mr. William Crookes the able editor of the *Chemical News*, appears independently to have discovered the useful properties of sodium amalgam, which is a remarkable specimen of condescension, seeing the gentleman is *not* an American.

Destruction of a Mill near Sheffield by the Bursting of a Fly-Wheel.—An accident of a very extraordinary character happened very recently, at Effingham Steel Works, Washford-road, Attercliffe, in the occupation of Messrs. Hodgkinson and Whitton, crinoline steel manufacturers. The scene of the accident was the rolling mills, in which were a large number of rolls, worked by a powerful engine, the fly-wheel weighing several tons. At half-past eight the works were stopped for breakfast, and the men and boys left the mill. Shortly before nine four of the number returned to resume work, the rest remaining in the yard until the breakfast-time expired. The engine was set in motion, and for a few minutes appeared to work well, but suddenly, from some unexplained cause, the fly-wheel broke into segments, and was followed by a terrible crash. The wheel appears to have been revolving with great rapidity, and immediately it broke the building was completely shattered. Two immense pieces struck the timber that supported the roof, and were hurled in opposite directions. One was thrown over the rolling mill, and fell close by Attercliffe Bridge—a distance of at least 150yds.—while the other passed over the front portion of the works, two storeys high, and fell in a field on the opposite side of the road, and became firmly imbedded in the ground at least 5ft. deep. No personal injury was caused by the accident, but it is believed that the damage to the building and machinery cannot be much less than from £1,200 to £1,500.—*Leeds Mercury.*

Plastic Slate Roofing.—The indomitable perseverance of our American cousins has lauded them on a claim for an original idea, which they make the most of. By grinding together slate-stone and coal tar, a slab is obtained, on passing the mixture between a pair of rolls, that can meet the requirements for roofing or paving. They almost exhaust the English vocabulary in its praise. *Ex gra*, no power can dissolve it. It is cheap and abundant in every civilised country on the globe, so simple in preparation and application, that common sense is the only qualification for using it. A mastic—it adapts itself to every shape and condition [possibly the writer is referring to its plasticity]. Adhesive—it needs no nails, or hooks to hold it. Noncombustible—it is not the means of destroying your property, but of protecting it. Impervious—water, nor can steam penetrate or dissolve it. Repairable—"a little more of the same sort," and a brush or trowel restores it after accidental injury, which, if judiciously applied once in ten or twenty years, it may last for ever!" Returning to the sober facts of the case, it is quite possible that we have in them the foreshadowings of a new and highly useful manufacture. The resources are as cheap as they are boundless. There are millions of tons of slate-waste, that at present remain without any value whatever; and there are many more millions of tons *in situ*, that do not come up to the standard of the taste or practical requirements of our architects, yet can be worked cheaply. A little steam engine could transform all this waste into highly desirable flooring and paving slabs, besides many other useful articles which suggest themselves.

Steam Fire Engine.—A new fire-engine has been sent into the dock-yard at Deptford by Messrs. Merryweather and Sons, and tried in the presence of some of the officers. The engine threw a 1⅛in. jet "considerably over the highest chimney shaft in the yard." Its professed capabilities include 1,000 gallons of water projected to a height of 200ft. per minute. Steam was raised from cold water in 8 min. 30 sec. to a pressure of 100lbs. After a continuous run of three hours, it was approved of. The dock-yards at Portsmouth and Devonport, have each an engine of the same description.

A French Story concerning the Atlantic Cable.—A French paper gravely tells its readers that "Lord P." went to the office of the Atlantic telegraph and demanded to send a message. Refused at first, he urged his point, and by a payment of two hundred guineas, *argent comptant*, succeeded. He was furnished with paper and ink, and wrote, "Send me the strongest spark you can. Lord P." Waiting a moment while the message was sent, he took out a cigar and held it to the end of the wire. The spark came, the cigar was lighted, and "Lord P." went out smoking. This is not told as a joke, but is given amongst the news.

Corrosion of Iron Ships.—A remedy appears to be dawning on the history of iron shipbuilding, against its rapid decay, which will be heartily welcomed by all concerned. The late Admiralty had entertained the proposition of Mr. Daft to protect the iron by zinc, having an intervening thickness of felt between these two metals. Of course the trial of its value involved a question of time. Sixteen months having elapsed since the commencement of this experiment, the sheet of iron protected by a sheet of zinc, and a sheet of felt between the two, was raised from the action of the sea-water in Portsmouth harbour, in the presence of the visiting Board of Admiralty. The result was satisfactory. The experiment had been judiciously varied by another arrangement bringing the two metals in direct contact, the result of which was highly satisfactory. We trust that the old complaint of the foulness of iron ships at sea, is entirely and economically got rid of. We, however, hope the remedy will be approached with proper caution, and carried out with sufficient watchfulness, until satisfactorily established in practice.

Centenary of Dr. Dalton's Birth.—The 5th ult., being the centenary of Dalton, the chemist, and discoverer of the atomic theory of definite proportions, the occasion was celebrated in Carlisle by a public dinner. Dalton being a Cumberland man, having been born at Eaglesfield, near Cockermouth in that county, the celebration was purely of a local character. Dr. Lonsdale, of Rosehill, Carlisle, presided.

American Atlantic Cable.—The Americans are jealous of the success which has attended the cable, and of its subsequent prosperous business. They have, accordingly, started a company for a new line from Cape Charles, in the Chesapeake, to Bermuda, and thence to the Azores and Lisbon (Portugal). This cable would be divided into three sections, and the longest—between the Bermudas and the Azores—will not be more than 900 miles. Before this scheme is realised, it is possible that the present telegraph line will have reimbursed the expenses of its projectors, and will be perfectly free to compete with its opponents.

Death of Mr. Hindmarch, Q.C.—We regret to announce the death of Mr. Hindmarch, Q.C., of the Northern Circuit, Recorder of York, and Attorney-General for the County Palatine of Durham. Mr. H. was only 62 years of age; he enjoyed the well-merited confidence of scientific men, and of patentees in particular.

The South-Essex Waterworks have been leased to Messrs. Easton, Amos, and Sons. The guaranteed dividend is 3 per cent. Of course it is confidently expected that this arrangement will work advantageously for the interest of all parties. The professed object of the company was of a decidedly philanthropic character, to bring pure water into London.

The Needle Gun.—In our last issue we contemplated a return to this subject. In doing so we find it replete with claimants for preference in every variety. Each is pronounced by its inventor to be superior to all other competitors. The Prussian government had to choose between the needle breech-loader and the old muzzle-loader, and their task was a very simple one. Our government had to decide on the merits of each of the many improvements which our skilled artizans introduced, hence the unavoidable delay. Decision has lighted on the Enfield musket, to be converted—on the score of economy—to a breech loader, on the Snider principle, and can be fired fifteen times a minute, which promises to be, when finished, a superior gun in many respects to that of the Prussian gun. The French government has been in a precisely similar state of indecision, from similar causes, as ourselves. They too have been compelled to arrive at a hasty preference, with what degree of success remains to be seen.

Nitroleum—the new Substitute for Gunpowder.—Two similar blocks of cast-iron weighing each 300lbs., had a hole 1in. diameter and 15in. deep bored in them, and were charged one with gunpowder and the other with nitroleum. The powder discharged through the fuse-vent 3-16ths in. diameter did no injury. The nitroleum tore the iron to pieces, the force extending downward from the bottom of the charge, leaving a cone with its apex at the bottom of the drill-hole. Four musket-barrels were placed in wrought-iron cylinders, two filled with gunpowder and two filled one-third full with nitroleum. The musket-barrels were exploded by electricity; those charged with gunpowder burst open, tearing the iron to pieces. The explosion of the barrels charged with nitroleum produced a very different effect; they were flattened, and not so much broken to pieces; the force was so sudden and great that after the barrel had irregularly broken up and down, the iron appeared like rolled plate—even and polished. The experiments appear to demonstrate that nitroleum for blasting operations, at least, presents undoubted advantages.

Mr. Abraham Darby, the managing director of the Ebbw Vale Company, performed the ceremony of opening the new blast-engine. During the last few years the works have undergone considerable alteration, and additions have been made in several departments. Improvements have been introduced, and scientific discoveries in reference to iron making have always received attention and encouragement from the directors of the company. The engine, which has been made on the most approved principles, has been erected by Messrs. Loam and Son, of Liskeard; the steam cylinder is 72in., and the blowing cylinder 144in., with 12ft. stroke. The fly-wheel is 30ft. in diameter, weighing 45 tons, with wrought-iron shaft 19in. square, weighing 8 tons. Air-pipe 6ft. in diameter delivering into a regulator 40ft. long and 14ft. in diameter. The massive piston-rods are made of the best Bessemer cast-steel. The beam is 40ft. long, and 7 by 6 deep at the middle, made from the Pontypool cold-blast iron. The timberwork was supplied by William Eassie and Co., Gloucester. The engine is intended to blow three or four new furnaces, one to be built forthwith, and the others as soon as practicable.

It has been estimated that the British public voluntarily taxed themselves last year to the extent of thirty-four millions of pounds sterling, which they paid to the railway companies for conveying themselves or their merchandise. It is confidently expected that this tax will rise to thirty-six millions of pounds in the current year. The Chancellor of the Exchequer reduces the taxes on the necessaries of life, and the people put this saving into locomotion, which is a wise investment, for it is simply profitable, when men grow rich by making this investment.

At the Meeting of the Electric and International Telegraph Company, the nett profit for the half-year was stated at £67,524, and a dividend of 5 per cent. for that period was declared. It was decided to carry the balance—£15,030—to the reserve fund, which now amounts to £86,380.

Contracts of Service Between Master and Servant.—Resolutions of Select Committee.—The report has been issued of the Select Committee of the House of Commons appointed to inquire into the state of the law as regards contracts of service between master and servant, and as to the expediency of amending the same. The committee agreed to the following resolutions:—1. That the law relating to master and servant, as it now exists, is objectionable. 2. That all cases arising under the law of master and servant should be publicly tried in England and Ireland before two or more magistrates, or a stipendiary magistrate, and in Scotland before two or more magistrates or a sheriff. 3. That procedure should be by summons in England and Ireland, and by warrant to cite in Scotland: and, failing appearance of defendant in answer to summons or citation, the Court should have power to grant warrant to apprehend. 4. That punishment should be by fine, and, failing payment, by distress or imprisonment. 5. That the Court should have power, where such course is deemed proper, to order the defendant to fulfil the contract; and also, if necessary, to compel him to find security that he will duly do so. 6. That in aggravated cases of breach of contract, causing injury to person or property, the magistrates or sheriff should have power of awarding punishment by imprisonment instead of fine. 7. That arrest of wages in Scotland, in payment of fines, should be abolished. 8. That, a suggestion having been made to the committee—viz., that in all cases of breach of contract between master and servant, it should be competent to examine parties as in civil cases, although the offence be punishable on summary conviction—the committee are not prepared themselves to recommend the adoption of such a principle, involving as it does departure from the law of evidence in such cases as now settled.

Coal.—Those who have advocated the conversion of our coal into cash—*prompt*—and so enrich themselves at the expense of our future well-being as a manufacturing people, take the cubic contents of a vein from its thickness and supposed area of extent. It does not suit their purpose to recognise any deficiency from "faults," nor the waste of 30 per cent., known to engineers in the "getting" of the coal.

The Cost of labour for coal cut by hand is eightpence per ton, with the machine from threepence to fivepence.

The hydraulic coal-cutting machine, with a supply of thirty gallons of water per minute, at a pressure of 300lbs., will do as much work as twenty men, and make less waste of coal.

The Bron-Wylfa Colliery Company have succeeded in reaching the four-foot coal 17yds. below the Cannel. This discovery is of great importance to the coal fields of Flintshire, inasmuch as every seam found under the main coal up to the present time has a corresponding seam and relative position in the Lancashire coal fields. Their identity is so sufficiently established that no reflecting and experienced person can any longer look upon it as a geological speculation. They have in Lancashire the king coal underlaying the Cannal at a depth of about 17 yards, and in two separate bands. Such is the four-foot coal of Flintshire, and we see no reason why such enterprising companies as the Bron-Wylfa, Bromfield, and Broncoed, should not continue their explorations until the Lancashire yard coal, bone coal, smith coal, and the celebrated Arley Mine coal shall be developed in their pits. The Flintshire coal fields are now attracting so much attention that in a few years they will vie with the Lancashire and Staffordshire in extent of enterprise and resources.—*Mining Journal.*

Stansty New Colliery.—The company which has been formed for the working of the minerals upon this estate commenced operations by boring on the 1st June last; and we have much pleasure in announcing that, owing to the skilful manner in which the work has been pushed forward, they pierced the first seam of coal last week. The works are under the management of Mr. W. Wynn Kenrick, mining engineer, of Ruabon; and the way in which the work has been pushed forward is alike creditable to his skill and the men in his employ.—*Wrexham Advertiser.*

The Don Valley Drainage.—Mr. J. Fowler and Mr. J. W. Bazalgette have proposed a scheme, after survey, for intercepting and diverting the sewage from Sheffield, Rotherham, Doncaster, and the surrounding villages, and applying it as manure to land suitable for the purpose, by means of works of irrigation. The remedy suggested by these gentlemen is to construct a sewer along the valley of the Don, from Sheffield through Rotherham to Doncaster, which would receive not only the sewage of those towns, now flowing into the river, but which would act also as an outfall for sewers, which may be hereafter constructed to meet the future requirements of the valley. From Doncaster they are of opinion that an open channel may be formed through the purely agricultural districts lying to the east, and to the north. This district is flat, and might, they state, be much improved in value by irrigating it with sewage; and there are large tracts of land almost wholly uncultivated which might be made of considerable value. Messrs. Fowler and Bazalgette assume that for this purpose the construction of about thirty miles of conduit from Sheffield to Doncaster, and thence east and north, would cost £300,000, which appeared to them a fair and sufficient estimate; and the project appeared to afford a reasonable expectation that not only would it pay its own cost, but that ultimately it would remunerate its promoters. The report, after alluding to Croydon, the town sewage of which is let for £5 per acre, says—"We consider the circumstances of the value of the Don of more than ordinary promise in a commercial point of view, and see no reason why a tract of about 5,000 acres of the poor lands, below Dancaster, should not, in the course of a few years, be improved under the influence of town sewage to the extent of at least £3 per acre per annum, thus producing a profit of £15,000 per annum. A penny rate upon Sheffield alone produces, we believe, about £2,500 per annum; therefore, assuming the sum of £350,000, including all expenses and contingencies, to be borrowed for fifty years, at the rate of 4½ per cent. per annum, a 7d. rate upon Sheffield alone, without the aid of adjoining districts, would pay off both the interest and capital; but a proportionate contribution from Rotherham and Doncaster and other places equally benefitted, would reduce the rate to less than 6d. This, however, is in the assumption that no return from improved lands is received in diminution of the rates; but judging from what we know to have been the result in other towns, and considering the favourable circumstances of the valley of the Don, we repeat our conviction that, under judicious management, the project may probably be made not only self-paying but ultimately even remunerative."

The Thames Embankment.—The foundation-stone of the Embankment of the south side of the Thames has been laid, under the auspices of the Metropolitan Board of Works, at that part of the Embankment adjoining Westminster Bridge. This work consists of river wall and embankment 4,300ft. in length from Westminster Bridge, to Gun House-alley landing stairs; and a carriage and footway, forming a direct thoroughfare, 60ft. wide, from the bridge to Vauxhall. The amount of contract is £309,000. The work was commenced by Mr. Webster, the contractor, in the autumn of last year. When completed it will include 195,000 cubic yards of excavation, 175,000 cube yards of filling in 37,000 cube yards of concrete, 28,000 cube yards of brickwork in Portland cement, 426,000 cube feet of granite, 56,000 cube feet of Yorkshire stone.

The Penalties of Genius.—A Prussian announced the other day that he had discovered a new cartridge, and an explosive bullet. But when he indulged in the poetry of this idea, and announced also his ability to make the Prussian army invincible, he immediately attracted the attention and paternal care of Fatherland. That Government placed a squad of twelve soldiers to guard and protect the inventor. If he writes a letter, it must be inspected before it may be sent off, and he converses with a visitor only in the presence of this guard, whose ears are disciplined and jealously open to any and every word that can convey the least fact connected with the secret, which must not be revealed. What polite attentions wait on genius in this our day, and how varied in character. Old Von "fuss and feathers" the general, has not a finer body guard than this poor genius has.

Carbonic Acid has been resolved by M. Deville, into carbonic oxide and oxygen. The temperature at which this was effected = 2,372°F.

Platinized copper vessels are said to equal those of platinum, for containing strong acids, and are of course much cheaper.

The Fertile Nile mud contains about six per cent. of organic matter, with about sixteen per cent. of soda, lime, potassa, and alumina.

The Yorkshire Agricultural Society.—The appreciative tact with which agriculturists receive the efforts of engineers to satisfy their requirements, is practically shown in the following extract of a report of the meeting of the above society which took place on the 8th ult. This branch of the profession is evidently growing into considerable importance, and excellence must be the natural consequence. The show of implements was one of the largest and finest ever exhibited at York. Nearly all the firms in the kingdom eminent for their manufacture of implements were represented, and exhibited specimens of their best manufacture. Most of the implements, especially those worked by steam, were in full working order, and in that manner were their capabilities explained to the curious, as well as to the farmers who intended purchasing. The grass mowers were of the most excellent description; and the great improvement that has been made in these machines during the last few years caused the competition that took place on the 5th and 6th July to be very close, and of course rendered the decision of the prize one of considerable difficulty. The following were the awards:—First prize to Mr. A. C. Bamlett, of Thirsk, for mower, price £26; second prize to Mr. Henry Kearsley, of Ripon, for mower, price £25. The judges commended the new machine, price £18, exhibited by Messrs. Burgess and Key, of London; and commended the machine exhibited by Messrs. Samuelson & Co., of Bandbury, price £18 18s. In coming to this decision, the judges say they were guided by closeness and evenness of cutting—a point of the first importance—strength and durability of machine, excellence of combination, and comparative draft.

Enterprise.—Mr. Thomas Snowdon, of Stockton, has recently purchased an island,—the Sladdero,—situate in the Gulf of Bothnia, Sweden. It contains an area of 9,000 acres of magnetic iron ore. This gentleman has had two steam vessels built, one of them has been launched by Messrs. Binnie and Co., of Middlesboro,' for bringing this valuable ore to England, where it will be melted and converted into steel, to which purpose it is peculiarly applicable.

Childs' Chairs.—Our American cousins have patented a mode of relieving the anxieties of fond parents for the moral and physical welfare of their offspring. The child, when sitting in a comfortable arm-chair, unwittingly registers the amount of food taken, and also its daily improvement, to the fraction of an ounce. The secret—which must be carefully kept, or *some body* might spoil the ingenious arrangement—is this; the seat of the chair and its furniture sits on a spring, and its action is measured on a properly graduated scale, which can be most accurately read off whenever "young turbulence" condescends to sit still. As some children "do not know when they have had enough," and it is absolutely necessary that they should know this, and remember it, too, through life, mamma can now decide for them without any qualms of conscience a salutary lesson is taught, and excess is avoided. Decision of character cannot be too highly valued, nor can it be too early instilled by precept and example into the budding intellect; therefore the means for attaining and enforcing this valuable essential. The patent chair must be conducive of happiness, and be highly prized by every healthy pater and materfamilias. *Verbum sap.*

Purifying Cane Juice.—The Spanish *savant,* Senor Reynoso, who received some 35,000 dollars from the Cubanos to bring his asserted discovery of a superior process into practice, has now made *his* process known. It consists, in the addition of alum to the juice, which was tried long ago, and abandoned for sufficient practical reasons. The only novelty about this process is simply impracticable. He professes to reduce the combined water to "the state of small pieces of ice," by a frigorific process, on the large scale, in a country where the thermometer stands at 80°, and "separates the ice by centrifugal machines." He completes the process by "evaporating this concentrated syrup in vacuo." This may be—to quote the Ettrick Shepherd—"what the learned ca' rigmarole," but it is *verdad* Spanish nevertheless.

TELEGRAPHIC ENGINEERING.

The Atlantic Telegraph Cable of 1865.—It is with perfect satisfaction we record the highly interesting fact of the recovery of the broken cable of the past year, of its having been properly spliced, and successfully landed in a perfect state of working order. The statistics put forth by the company after the breakage of last year are worth quoting.—Estimated Revenue: Assuming that the charge for transmission of messages between the Old and the New World be fixed at 5s. per word, and that the speed of working be limited to only five words per minute during the twenty-four hours per day, and allowing 300 working days in the year, one cable would produce a gross annual revenue of £540,000, to be divided as follows:—Working expenses, say £25,000; interest at five per cent. on £100,000. Atlantic Telegraph Debentures, £5,000; Anglo-American Telegraph Company, £125,000; Atlantic Telegraph Company's Preference Shares, £600,000 8 per cent., £48,000; Atlantic Telegraph Company's Ordinary Shares, £600,000 4 per cent., £24,000; Balance divided—Anglo-American Telegraph Company, £156,500; and Atlantic Telegraph Company, £156,500. Total, £540,000. To the £281,000 above shown as coming to the Anglo-American Telegraph Company from the revenue of the cable, the sum of £25,000 must be added, granted as a subsidy by the New York, Newfoundland, and London Telegraph Company, which will make a total income of £306,500, or over 50 per cent. net upon the capital of the Anglo-American Telegraph Company. As the price charged is £1 instead of 5s. per word, the above sum—always assuming the official calculations to be correct—must be multiplied by four. If the cable of 1865, over which the Anglo-American Company has the same rights as that of 1866, be raised, the amount must be multiplied by eight. In other words, the annual revenue of the company on a capital of £600,000, will be by its own showing two millions four hundred and fifty-two thousand pounds. These figures are startling as an Arabian Nights' story. But it must be remembered that the whole enterprise has been looked on for years as a romantic dream. The promoters of Atlantic telegraphy have borne the brunt of lukewarmness, ridicule, and opposition, and the vast rewards they seem on the eve of grasping are not half so extravagant as their project was pronounced to be by many sound men of business not many weeks ago.

The Atlantic Cable.—The "conductivity" and insulation of the cable exceeds the most sanguine expectation. Messages have been transmitted at the rate of 14½ words per minute, without the necessity for repeating. A message can be delivered in London within half an hour of its being received in New York, or *vice versa.* Although we witness so much of ease in the task, and of facility in the associated operations, we also know that these results have been brought about at an enormous outlay of money. Those who require these facilities are the best qualified to bear their share of the burden of those expenses which made the task of sending messages an easy one. According to the present rate of the charges, it is a calculated fact, that by sending only three words per minute the cable can earn £1,500,000 per annum. A modification of its tariff is expected in favour of the press.

MINES, METALLURGY, &c.

The Dissociation of Gases in Metallurgical Furnaces.—The *Comptes Rendus* contains a note by M. L. Cailletet on this subject, which appears to deserve some attention. This French *savant* records some curious experiments which show that at very high temperatures compound gases become separated into their elements, and that at such temperatures these gases have no distinct action on each other. He heated metal in a fire of coal and wood charcoal to such a temperature that platinum was easily fusible in it. The experiment was conducted in a porcelain tube, from which the gases were afterwards collected. The analysis of these by M. Péligot gave the following results:—

Oxygen	15·24
Hydrogen	1·80
Carbonic oxide	2·10
Carbonic acid	3·0
Nitrogen	77·86
	100·00

These results proved that oxygen has no action upon hydrogen, carbon, or carbonic oxide, in the midst of a combustible mass which is maintained at a temperature higher than that of the fusing-point of platinum.

How Mining is conducted in California.—We extract the following, *verbatim ad literatim,* from the *Mining and Scientific Press* of San Francisco, California. There is a point in it that will make every miner smile on reading it. "Cross course" cannot be a lode; and when two veins cross, they also are *richest* at "the junction." There must have been a miner in that "Poorman" crowd. The Hays and Ray lode, as claimed and staked in August last, was 1,600ft. long. A month later, other parties claimed and staked for 1,400ft. a lode which they called the Poorman, crossing the Hays and Ray near the middle, at an acute angle, the two lines of stakes exactly representing the letter X The Poorman began to work their alleged lode, not at either end, but at the very point of crossing the Hays and Ray, and there struck a pocket or chimney of ore of unprecedented richness—indeed almost pure silver. Portions of this ore actually yielded by the mill process 50 to 60 per cent. of silver—a result never before equalled in mining history, and giving rise to the report that Idabo miners had found the silver in "chunks" as large as candle-boxes. It is claimed that they took out 250,000 dols. in two weeks. They certainly harvested large quantities of ore, and carried it away by night on the back of mules, over the mountains, to be crushed in Portland, Oregon. Probably it is the first silver ore ever discovered which would pay to steal or carry away 500 miles in a crude state. The Hays and Ray claimed that the Poorman Ledge did not exist, but that the adverse party were taking out and reducing their ore. The "Poorman" not only denied this, but with an armed force drove off the Hays and Ray workman from a portion of the ledge, and threatened bloody warfare unless they could have their "rights." After long investigation Judge Myron Kelly, of the United States District Court, granted an injunction restraining the Poorman party from taking any more ore at present, ordering both contestants to sink shafts and trace their lodes to the disputed point, that a jury might determine which actually owned the ground. This decision, obviously just and equitable, caused intense indignation among the discomfited suitors. It was even threatened to tar and feather the Judge, and a strong attempt is being made for his removal.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated August 22nd, 1866.

2150 R. Wappenstein—Carriage for railways and overhead railways
2151 J. M. Hyde—Method of constructing armour plated ships and vessels
2152 H. R. Minns—Improvements in fire and thief proof safes
2153 H. Caro—Colouring matters
2154 F. Howard—Self-raking reaper
2155 W. Tongue—Machinery for preparing, straightening, and combing fibrous materials
2156 G. Haseltine—Process for bleaching with the aid of hydrostatic and pneumatic pressure
2157 G. Carter—Propelling ships and other navigable vessels

Dated August 23rd, 1866.

2158 R. H. Tweddell—Punching and rivetting machines
2159 S. A. Main—Breech-loading and other firearms and bayonets for the same
2160 J. Livesey and J. Edwards—Permanent way of railways and signals for working the same
2161 J. A. Coffey—Self actiug steam and liquid safety gauges
2162 T. W. H. Newbold—Manufacture of cornices, cornice pole ends, curtain bands, and curtain pins
2163 W. Harrison—Apparatus to facilitate communication between the passengers and guards or drivers of railway trains
2164 A. Gerard — Obtaining motive power and apparatus employed therefor
2165 P. V. Bailleul—Reaping machine
2166 T. Alleu—Machinery for cutting splints for making matches
2167 E. Rimmel—Raising liquids
2168 W. Welch—Manufacture of cement compositions
2169 A. Long—Fountains
2170 W. E. Gedge—Improved saw for forest use
2171 J. Johnson — Submarine rakes for gathering oysters or other articles
2172 W. E. Newton—Mode of preventing eggs of all kinds from spoiling
2173 W. Bayne—Hat stretcher

Dated August 24th, 1866.

2174 J. B. Fell—Locomotive engines and carriages for steep inclines
2175 R Tonge—Machinery for folding fabrics and inserting cardboard or other substances between the folds
2176 H. Wren and J. Hopkinson—Machinery for winding yarn and thread
2177 J. T. Poyser—Machinery employed in dressing, screening, and separating grain, and for other similar purposes
2178 J. Booth—Metallic pistons
2179 P. A. De Bereuger—Lime and cement kilns
2180 F. H. Danchell—Manufacture of floor cloths and coverings and similar called fabrics
2181 W. E. Newton — Improvements in organs, pianofortes, and melodeons
2182 E. T. Bousfield—Construction of reaping and mowing machines
2183 J. G. Jennings—Improvements in water closets, urinals, and taps

Dated August 25th, 1866.

2184 E. Green—Improvements in gearing for driving scrapers employed in cleansing the flues and tubes of boilers and heating apparatus
2185 W. L. Owen—Working switches and signals of railways
2186 C. Richardson—Looms for weaving
2187 W. E. Newton—Breech-loading firearms
2188 G. Little—Manufacture of "Tin drums," or rollers used in machinery for preparing and spinning fibrous materials
2189 W. D. Gainsford—Railways and engines for use thereon
2190 G. T. Bousfiled — Combing wool and other fibre
2191 J. O. York—Ships or vessels
2192 G. Hunter and W. F. Cooke—Machinery and tools for cutting slate, stone, marble, and other minerals
2193 S. Plimsoll—Means and apparatus for facilitating and perfecting the unloading of coals and other goods from railway waggons
2194 W. Clark — Felting hats and other felted fabrics, and apparatus for the same
2195 J. F. M. Pollock — Machinery for pressing bricks, tiles, corbels, or other plastic work
2196 E. Brooks—Breech-loading firearms, and cartridges for breech-loading firearms
2197 C. McFarland—Friction clutch for starting and stopping machinery
2198 G. Haseltine—Churns
2199 C. T. Porter—Steam engines

Dated August 27th, 1866.

2200 E. Lamb—Construction of apparatus for cleaning and polishing boots and shoes
2201 W. Pierce—Method of purifying gas
2202 J. Northrop — Apparatus to be used in the fringing and trimming of shawls, mantles, and other fabrics requiring fringes or trimmings
2203 C. E. Brooman — Improvements in or connected with carriage breaks
2204 H. A. Dufrené—Manufacture of beer and other alcoholic liquids, and the apparatus employed therefor
2205 W. Krutzsch—Construction and combination of breech-loading and repeating firearms and ordnance, and in the cartridges for use in the same
2206 T. Davis—Method of or apparatus for ventilating dwelling houses or other buildings
2207 J. Farmer—Apparatus for regulating the flow of steam into steam engines by what are commonly called expansion cut off valves

Dated August 28th, 1866.

2208 J. Proctor—Chimney pots or terminals
2209 T. W. Barber and W. Barber—Breech-loading firearms
2210 W. Gould—Reflecting various coloured lights and shades upon stereoscopic and other objects for producing different effects upon them, also to use a rack movement instead of the ordinary set screw to adjust the instrument
2211 L. Delagarde—Binding hooks
2212 R. Buckton—Looms for weaving
2213 J. Forster—Machinery for the manufacture of spool tubes and cartridge cases
2214 G. H. Bovill—Manufacture of rails for railways
2215 W. E. Newton—Mode of preventing oxidation of lead balls in fixed ammunition
2216 H. Morgan — Pulleys for hanging balance sashes
2217 R. H. Hudson—Preventing the fouling by and clearing ships' propellers from ropes
2218 R. Irvine—Treating and purifying water
2219 J. H. Johnson—Railway breaks
2220 W. Clark—Ornamenting lace
2221 H. Carrier—Looped fabrics

Dated August 29th, 1866.

2222 W. T. Eley—Machinery employed in the manufacture of "Boxer" or other central fire cartridge cases
2223 T. Whitby—Constructing vessels of war
2224 E. T. Hughes—Improvements in repeating firearms
2225 J. C. Dickinson—Improved dipping mixture for sheep and lambs
2226 J. Richards—Carriage axle for roads
2227 T. Torner—Improved cartridge or cartridge-case extractor for breech-loading guns
2228 W. C. Brookes—Balling wool
2229 J. G. Tongue—Looms
2230 J. Davis—Treating limestone and applying the products for purifying and rendering water palatable
2231 W. E. Newton—Improvements in breech-loading fire-arms
2232 J. Loehl and Ignac Pick—Improvements in muffs, bags, pockets or similar receptacles

Dated August 30th, 1866.

2233 S. B. Simon—Lifting jacks
2234 D. Cnlnou—Improved crank for single or double purchase crabs or winches
2235 A. J. Clairmonte — Elastic tubular india-rubber air chambered pannels
2236 J. M. Mellor—Softening, disintegrating, and bleaching vegetable fibres
2237 W. Clark—Improvements in apparatus for propelling and steering vessels
2238 T. Gill—Improvements in machinery for working stone
2239 R. Daglish—Steam generators
2240 J. H. Johnson—Improved pavement for roads and streets
2241 H. E. Newton—Improved process for preserving beer
2242 W. E Newton—Improvements in machinery for hulling and cleaning coffee berries or seeds
2243 A. Albini—Improvements in breech-loading fire-arms

Dated August 31st, 1866.

2244 C. D. Abel—Joints for pipes
2245 A de la Gantrnye—Preservation of wood
2246 J. Owens—Looms for weaving
2247 W. E. Newton—Improved apparatus for boring boiler tube heads, drilling angle holes, or cutting circular grooves in metallic substances
2248 H. G. Scott—Valves for pumps

Dated September 1st, 1866.

2249 J. O. Greenwood—Improvement in certain textile fabrics
2250 G. T. Bousfield—Improvements in machines for making eyelets
2251 E. V. Billiotte—Needle-case or holder
2252 A. Lebaudy—Improved solder or composition for joining certain metals or uniting fractures in certain metals
2253 P. F. Michaud—Improvements in weighing machines
2254 J. Baker—Reaping machines

Dated September 3rd, 1866.

2255 S. Vickess—Improved method for facilitating moving of moulds and draining syrup from sugar solutions
2256 A. W. Hosking—Improved detector for rendering safes secure from burglary
2257 R. Frost — Improvements in apparatus to facilitate the teaching of writing and drawing
2258 M. Knowles—Improvements in looms for weaving carpets
2259 D. Caddick—Improvements in the working of furnaces for puddling, balling, heating, and melting metals
2260 E. Lamb—Improvements in fixing the soles and heels of boots and shoes
2261 H. A. Bonneville—Improvments for detaching boats from their davits
2262 H. A. Bonneville—Improvements in apparatus to feed horses
2263 H. A. Bonneville—Improved smoke-consuming fire-place
2264 H. A. Bonneville—Hoop skirts
2265 J. C. Haddan—Improvements in carriages for field artillery
2266 C. E. Brooman—Bleaching fibres and fabrics of vegetable origin
2267 E Russ, H. Hammond, and E. Hammond—Improvements in fire-arms
2268 W. C. Cambridge—Improvements in clod-croshers and press wheel rollers

Dated September 4th, 1866.

2269 E. Nelson—Improvements in treating certain fibrous vegetable substances so as to render them suitable for the manufacture of textile fabrics
2270 G. White—Rotary steam engine
2271 W. C. Holmes and J. W. Perkins—Improvements in apparatus for the distillation of paraffine and petroleum or other hydrocarbon oils
2272 C. Reeves—Improvements in cartridge case extractors for breech-loading fire-arms
2273 A. Paraf—Improvements in the extraction of iodine and bromine from kelp
2274 J. B. Brown — Improvements in mowing machines
2275 G Lowry—Improvements in machinery for spinning flax
2276 E. Funt—Pianofortes

Dated September 5th, 1866.

2277 W. T. Sugg—Apparatus for regulating gas
2278 T. G. Webb—Furnaces for the manufacture of glass
2279 J. Leetch—Breech loaders
2280 J. Wilson—Street gas lamps
2281 C. Cetti—Construction of the ceilings of buildings
2282 H. Knox—Signalling an alarm from railway carriages when in motion
2283 H. Robins—Sheathing iron ships
2284 R. S. M. Vaughan—Apparatus for cleaning and polishing boots, shoes, and knives
2285 A. V. Newton—Constructing electric clocks

Dated September 6th, 1866.

2286 J. Edwards—Improvements in the permanent way of railways
2287 W. P. Bardell—Gun and pistol locks
2288 W. Cuthbert—Steam whistles
2289 P. Smith — Improvements in making wool guard, coverings of gill boxes for the preparing and drawing of wool, silk, mohair
2290 W. Selby—Manufacture of ornamental lace
2291 G. Pimm—Ovens for baking
2292 J. Bullough—Looms for weaving
2293 G. V. Fosbery—Locks and other parts of breech loaders
2294 T. Beruey—Construction of ships

Dated September 7th, 1866.

2295 A. H. Hart—Apparatus for signalling on railway trains
2296 C. D. Abel—Slide valves for steam engines
2297 J. A. and J. W. Asquith—Machinery for cross raising the nap of woollen cloths
2298 J. Schneider—A process of making improved beer and ale
2299 J. H. Johnson—Improvements in hats or coverings for the head
2300 J. Lochhead—Arrangement of machinery for sawing timber
2301 C. Defries—Improved float light
2302 J. Kitchen, W. Kitchen, and S. Samuels—Railway break
2303 A. Mackie—Machinery for composing type
2304 C. E. Brooman—Breech loading firearms and cartridges to be used therewith
2305 W. F. B. Kleiu—Roller skates

Dated September 8th, 1866

2306 E. T. Hughes—Water power engines
2307 M. Tossell—Chimney cowl or ventilator
2308 C. Catlow—Looms for weaving
2309 A. F. Chapple—Ink supplying penholders
2310 C. F. Allhon—Boots and shoes
2311 C. Hodgson and J. W. Stead—Weighing machines and indicators
2312 C. E. Brooman—Cup for containing and supplying oil for lubricating purposes
2313 J. Silvester—Manufacture of the handles of sad irons and other smoothing and tailors' and hatters' irons
2314 C. T. Burgess—Reaping machines
2315 F. Warner, W. Stewart, and G. W. Barber—Water closets
2316 W. Clark—Leather and machines for manufacturing the same

Dated September 10th, 1866.

2317 W. Frankland — Lubricating the valves, pistons, cylinders, and all internal parts of steam engines where the steam has access
2318 W. Vincent and G. R. Westcott—Lighting the floats of lights in theatres and other places
2319 A. V. Newton—Manufacture of seamless metallic tubes
2320 C. Bathoe — Composition to be employed in architectural mouldings, and for other useful and decorative purposes
2321 C. F. de Gaudel—Making boot legs of one piece
2322 W. E. Gedge—Manufacture of articles used in sadlery and harness, &c.
2323 W. E. Gedge — Manufacture of calcareous bricks or artificial stones
2324 P. J. Railton and D. Walton—Machinery for twisting into hands cotton, linen, woollen, silk, hemp, or wire
2325 E. Fitzhenry— Machine which may be employed for scouring, sleeking, or setting hides or leather
2326 E. Harlow—Breech-loading firearms, revolving firearms, and cartridges for the same
2327 W. J. Curtis—Steering steam vessels
2328 R. A. E. Scott—Gun carriages
2329 J. H. Johnson—Electric telegraph conductors
2330 R. Bennett—Obtaining and transmitting motive power

Dated September 11th, 1866.

2331 W. Olley—Separating animal and vegetable matters from water and other liquids
2332 T. Baldwin—Steam boilers
2333 R. A. Hardcastle—Apparatus for measuring and indicating the quantity of liquid drawn off thereby
2334 F. A. Paget—Connecting parts of machinery and structures liable to impulsive forces
2335 T. C. Lewis—Construction of pianofortes
2336 W. E. Gedge — Machine for manufacturing leather straps, belts, or bands for driving machinery, and for other purposes
2337 R. A. E. Scott—Model of mounting and working revolving and other guns
2338 R. A. E Scott—Gun carriages and platforms or slides
2339 G. T. Bousfield—Marine steam boilers

Dated September 12th, 1866.

2340 W. E. Gedge—Indicator or register
2341 B. Lietar—Welding iron upon iron, steel upon steel, and iron upon steel
2342 J. Williams—Two wheeled carriages
2343 J. P. Bright—Manufacturing, decorating, and ornamenting articles of furniture
2344 M. J. Haines—Leather straps or driving bands
2345 S. Woodall and J. M Van Winkle—Mode of and means for uniting and securing the ends of hands or hoops designed for baling cotton, wool, and other substances
2346 T. Wheelhouse—Apparatus for sanitary purposes
2347 E. H. Haydon and E. Pocock—Machinery for cutting rags, ropes, and other articles for paper making and other purposes
2348 J. Davey—Thrashing machines
2349 G. B. V. Arbuckle—Invention of immediately giving the alarm in case of fire in any building or ship whatsoever, wherever it may be placed

Dated September 13th, 1866.

2350 E. Phillips and J. Howie—Machinery to be employed in cutting textile fabrics
2351 W. Clark—Manufacture of cloth and pile fabrics
2352 J. L. Norton— Washing and cleansing wool and other fibrous materials
2353 F G. A. Horstmann — Mode of obtaining motive power
2354 R. Robinson — Travelling or fitted dressing bags
2355 L. Bing—Determining the actinic power of light
2356 J. H. Betteley—Ships' anchors
2357 G. Henderson and D. McNeil—Hydraulic gas chandeliers and gas regulators applicable thereto, and to other gas burners or meters

Dated September 14th, 1866.

2358 R. R. Riches and C. J. Watts—Horse hay rakes
2359 C. H. Cheshire—Metal spring box or case for fusees, cigars, and other purposes
2360 A. Cairns—Construction of liquid compasses
2361 J. J. Baranowski—An appliance to be used in conjunction with corks for closing bottles, jars, and other similar receptacles
2362 G. Robinson—Manufacture of ammonia, baryta, and strontia
2363 C. F. Varley—Apparatus for obtaining latitude and longitude
2364 C. P. Stewart and H. Chapman—Tools for cutting, drilling, slotting, slot drilling, shaping, and planing metals and other subtances
2365 J. H. Johnson—Machinery for cutting frets in metal or other substances
2366 A. Oldham—Metallic pistons
2367 J. Boyd, J. McPherson, T. K. Kerr, and J. Taylor—Winding apparatus
2368 J. Bindley—Machinery employed in the manufacture of fish hooks
2369 W. Tunstill—Braiding machines and warp regulators
2370 R. Couchman—Boxes or cases for packing and exhibiting goods or articles of various kinds

Dated September 15th, 1866.

2371 J. Keyston—Substance to be used instead of whalebone in the manufacture of whips and other articles
2372 N. Dunn—Water tuyeres
2373 T. Newey—Fastenings for the bands of purses and pocket books
2374 B. Baylis—Manufacture of iron
2375 C. C. Connor—Means for the treatment of flax, tow, hemp, and other vegetable fibrous matters
2376 W. Creasy—Drying or otherwise treating grain and other substances
2377 A. B. Baron von Rathen — Compressed air engine
2378 J. J. Twibill—Steam generators or boilers

Dated September 17th, 1866.

2379 J. Jackson—Construction of ships' anchors
2380 P. Brash and W. Young—Oil from shale and other bituminous substances
2381 R. M. Letchford—Wicks for burning
2382 J. Dunn—Spinning wool
2383 E. Wall—Elastic waist for boots
2384 W. E. Gedge—Improved railway
2385 J. Dodge—Cutting file blanks
2386 J. H. Johnson—Bricks and tiles
2387 D. McDowell — Cleaning the tubes of steam boilers
2388 G. T. Bousfield—Steam jets
2389 G T. Bousfield—Felting hat bodies
2390 G. Dyson—Smelting of iron


Lundy Isle
East
Quantockshead
Soundings
Roches Bonnes
Sevre R.
Rochelle
I. Re
I. Oleron
Rochefort
Charente R.
MOUTHS OF R. CANENTELLUS
PROM. SANTONES
Cordouan
R. Gironde
Coast
MOUTHS OF R. CARUMNA
Bordeaux
HARB. SANTONES
Arcachon Bank
Arcachon
Meridian of Greenwich
PROM. CURIANUM
Line
Nautical Miles
Soundings from 150 to 200 fathoms. Rocky bottom
PROMONTORY BEYOND THE W. OF PYRENEES
MOUTH OF R. IGMANUS
R. Adour
HEAD OF RIVER.
Pyrenees
Bidassoa
Bilbao R.
OF RIV. ATURIUS
NOTE
By request of the Author this Map is unshaded

THE ARTIZAN.

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ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 220.)

(*Illustrated by Plate* 307.)

Saint Malo and neighbouhood.

91. D'Argentre says*: "One finds that in times past the town of S. Malo was not all sides surrounded by the sea, which always since then has gained upon it very far at this side, so that the marshes which were between the town and Sesember (which is an island about two leagues distant,† in which there is a convent of Cordeliers) was terra firma, and it appears by the accounts of the revenues of the bishopric of the chapter of this church, that the receivers had made a charge and discharge of the revenue of the marshes between the town and the convent of Sesembre, and even now the receivers have had a chapter of accounts of monies due and not received. And there is found in the registers of the "Senechaussée" of Rennes,‡ that formerly there was a trial between the Duke and the bishops, for the pasturage of the above-mentioned marshes; where the Duke pretended that his people had the right of leading their cattle in common."

92. On this Manet remarks at p. 105:—"What the Historian of Britanny says here, was practised for a long time to maintain possession of the land *in case the sea had retired from it*,§ is very certain, and perfectly agrees with the original pieces from which we are about to recite some extracts. A register of the chapter, in fact, commencing in 1415, reports formally that a certain person was condemned for having let his cattle escape inte the meadows of Césembre. Under the date of 1425, the same register contains an account rendered the preceding year, by the Jean Billart named, receiver of the Chapter-house, which charges him with having received 21 livres 8 sols of Colas Gochard, farmer of the meadows of Césembre. It contains another account signed, by Dom Pierre Billart, in 1437, who at this period (the last, probably, of these meadows) had again farmed them at 30 sols to one called Charles Cauchart. Finally, in 1486, the same Pierre Billart, or another of the same name, 'does not account, and does not charge himself with the farm of Césembre, because the said receiver has not enjoyed it.'" Between 1437 and 1486, probably about the former date, the meadows appear to have sunk.

93. Manet proceeds (p. 106):—"One could, if there was need, add to all these historical and physical demonstrations, that in the different statements rendered to the dukes and kings by our bishops, until the 29th December, 1689, all the range of rocks named les Portes, the isles of Césembre, Harbour, Great and Little Bés, les Marais, Talards, &c., are designated as if they were dependencies of the ecclesiastic Lordship of S. Malo, and not as appurtenances of the ducal or royal domain, like other isles situated in the sea and the rivers; and that these statements were always received by the chamber of accounts without blame or dispute, which would certainly not have taken place if the pretensions of our prelates had not rested on a notorious fact, namely, that this skeleton of a continent which had been devoured; from all antiquity made part of the territory of the churches of Aleth and S. Malo."

He says at p. 5 that S. Malo was originally situated in the middle of a marsh.

94. Manet also gives (p. 13) the boundaries of the meadows of Césembre, long known by the name "Prairies de Césembre," namely, "les Herbières, les Rats, la Pierre-aux-Anglais, Dodehal, les Coquières, les Hongréaux and la Roche-aux-Dogues." And he says the meadows have for their base the actual rocks called the "Bons-Hommes," to which, of course, must be added Césembre itself. The meadows are defined on the map, and doubtless would have appeared in Bianco's chart, referred to in Art. 54, if its hydrography had been correct, which it is not; and if its scale had been large enough. But the scale is only an inch to 100 English miles.

95. "Submarine trees on our shores are covered with about two feet of mud at extreme low water, at S. Suliac and the Bay of Dinard drawing near the Little Port—if we may believe M. Brisart who says he has seen them more than once. In nearly all the other slopes which border the coast on the west, these stumps are scarcely deeper buried; especially in the sands of Port-Blanc, of la Garde-Guérin, of la Fosse-au-Veau in Saint Lunaire, and of Port-Hue in Saint-Briac.*

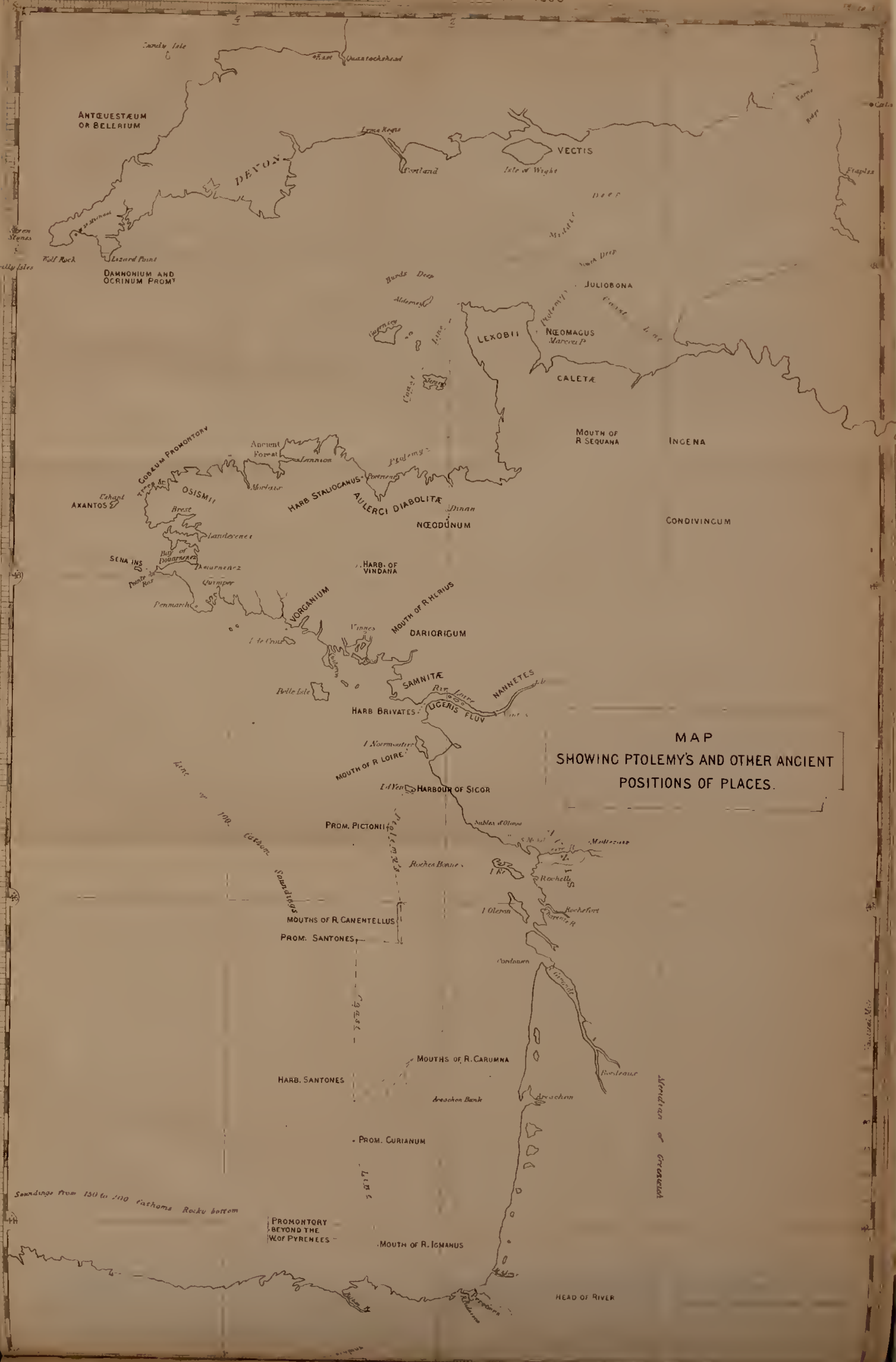
96. M. Ogée, Geographic engineer of Bretagne, says:—† "The sea has insensibly gained in this part a very vast territory, and whilst it has retired from the coast, to the south-west of Bretagne,‡ it has invaded the lands situated at the north of the province. A famous trial between the Dukes on one part, and the Bishop and Chapter of S. Malo on the other, informs us that the land situated between the city and the Isle of Césembre, which is distant about a league, and that which is situated between the city of Aleth and Dinard, [which latter is opposite to Aleth on the other side of the Rance] offered to view Meadows and Marshes which belonged to the Chapter. The Duke of Bretagne claimed these domains; but the decision of Judges of the Sénéchaussée of Rennes was not favourable to him, and the receivers of the Bishop and Chapter have made mention [of the meadows and marshes] again and again, although they have obtained no revenues. *This is a very wise precaution for the maintenance of their rights, in case they might some day become of value.*"

This last sentence which we have italicized intimates a belief in the possibility of the land rising again, and shows that the former owners still lay claim to the lost lands. And the sea which covers them is in consequence, not a part of the high sea, but is private property and consequently neutral; which will be treated of in the chapter on neutrality.

97. *Parishes and other places now missing.*—In Articles 68 and 69 preceding, we have specified ten parishes destroyed (though some of them were afterwards recovered by embanking); Ogée in Vol. 2 of his *Dictionary* says that Tommen or Thomen (which is some three miles south of Cancalle Point) now only a rock, was until the 14th century a parish of the same name of great extent. The parish of Bourgneuf was not submerged until about the 15th century. The sea uncovers sometimes under the sandy shore, portions of walls which formed the houses of villages which it has destroyed. The inundation of 709 was not the only fatality in this country; we know that the parishes of S. Louis, Maunay

* Hist. Bret., Folio 72A, 1611. (And M.S. Appendix, p. 635.)
† It measures 2½ English miles on the French Chart.
‡ D'Argentre himself was Seneschal.
§ This apparently affords a clue to the origin of the famous neutrality, of which more presently.

* Manet p. 90. † See his Dictionary, Vol. 4, p. 266.
‡ He doubtless refers to the Aunis, to be hereinafter described.


MAP
SHOWING PTOLEMY'S AND OTHER ANCIENT
POSITIONS OF PLACES.
Quantockshead
ANTŒUESTÆUM
OR BELERIUM
DEVON
Lyme Regis
Portland
VECTIS
Isle of Wight
Wolf Rock
Lizard Point
DAMNONIUM AND
OCRINUM PROMY
JULIOBONA
Alderney
LEXOBII
NŒOMAGUS
CALETÆ
MOUTH OF
R SEQUANA
INGENA
Ancient
Forest
Lannion
GOBÆUM PROMONTORY
OSISMII
AXANTOS
Brest
HARB STALIOCANUS
AULERCI DIABOLITÆ
Dinan
NŒODUNUM
CONDIVINCUM
Landerenec
SENA INS
Quimper
Penmarch
HARB. OF
VINDANA
VORGANIUM
MOUTH OF R. HERIUS
DARIORIGUM
Belle Isle
SAMNITÆ
NANNETES
HARB BRIVATES
LIGERIS FLUV
MOUTH OF R LOIRE
HARBOUR OF SICOR
PROM. PICTONII
Rochefort
MOUTHS OF R. CANENTELLUS
PROM. SANTONES
Bordeaux
MOUTHS OF R. CARUMNA
HARB. SANTONES
Arcachon
PROM. CURIANUM
Meridian of Greenwich
Soundings from 130 to 200 fathoms Rocky bottom
PROMONTORY
BEYOND THE
W. OF PYRENEES
MOUTH OF R. IGMANUS
HEAD OF RIVER

la Feillette, and Paluel existed until the 12th century. Gifts of property situated in those parishes, made to the Abbey of Vieuxville, attest their existence. The synodal books of the bishopric of Dol, bear their names up to 1664. A violent hurricane uncovered in 1735* some ruins of Paluel submerged in 1630; a vessel for holding holy water of the ancient church, was found, and the wells in which were preserved some vessels of tin. One distinguishes still the streets and foundations of the houses of this town. He also mentions† that at S. Pol-de-Leon (much to the west of S. Malo, but on the north coast of Britanny), "one only parish named the Minihi, formed out of seven which existed formerly." There was also the parish of Ecrehou "in Jersey," see Archives of S. Lo quoted already; and the parish of Vivier, all situated on the north of Britanny except Ecrehou. In all no less than twenty parishes appear to be missing, without including any of those which must have been lost on the west coast of Normandy.

98. There are missing the great village of St. Anne, a town called Moulin du Buot, St. Etienne du Paluel, of which the streets and ruts of carriages could be distinguished so lately as 1735. The isle of Herpin and Port of Winiau are also missing. In 1427 an earthquake is said to have overturned part of Nantes, and swallowed up thirteen villages near Dol. The cities of Tolente and Occismor and Ptolemy's Habour of Staliocanus are now gone. Under the heading "Ptolemy," we shall see that the Harbour Staliocanus was probably identical with the present Harbour of Portrieux.

As to the Depth of the Sinkings.

99. *Lost Monasteries and Town, and Comments.*—Manet and others give the names and positions of several monasteries, and the former gives (p. 59) also the name of a "Bourg" or town, which were once standing in that part of the forest of Sciscy now overwhelmed by the sea. The monastery of St. Moack's, he says, is five leagues from Dol going towards Chausey and one league north-north-west of the *Bourg de Lhankafruth.* The writer has therefore placed the Bourg on the great military road, at a place which agrees very nearly with Manet's description of its situation; the line of the road itself is copied from one of his maps. The monastery is of course placed a leagne north-north-west of the Bourg. At the Bourg there is now about six fathoms of water at low water, and at the monastery (which falls close to Manet's coast line previous to 709) there are between seven and eight fathoms at low water. Manet says that Rivallon brother to Judicaël‡ king of Bretagne, had in the Bourg one of his hunting boxes. Violent as he was, in a fit of passion, he caused the monastery of S. Moack to be burnt; but afterwards being penitent he re-established it in a better state, at the suggestion of S. Thurien or Thuriave, bishop of Dol.§

100. St. Scubilien founded the monastery of Menden 1,600 toises (3,410 yards, nearly two English miles), north-north-east of the isle of Aaron, on which S. Malo stands, which Manet says must be carefully distinguished from Mandan, which is near Chausey. The sounding at *Menden* at low water is by M. Beautemps-Beaupre's chart, 24 French feet, equal to 25½ English feet.

Note. Manet gives in one of his maps a league as 2,400 toises. And in Sir John Herschel's *Outlines of Astronomy*, 1864, p. 716, the toise is stated at 6·394593 British feet. Hence a French league is equal to 5,115⅔ yards. These measures we have adopted.

101. The monastery of Taurac or Caurac was 1700 toises to the east of Cancalle Point, or 2 English miles and 203 yards. At this place there are about 9 fathoms at low water.

102. M. Edouard le Héricher, who has extensive philological and local antiquarian knowledge, says the monastery of Mandan was six miles [west] from S. Pair (a village on the coast two miles south of Granville); at that place there are 5½ fathoms at low water.

103. Now supposing the positions of these monasteries and Bourg to have been correctly given, they evidently help to an approximation to the amount of sinking; because if we assume the Bourg and each monastery to have originally stood, say ten feet above the highest tides (they can scarcely have been less), and add to that the rise of tide and the sounding for each place, the sums will approximate to the total sinkings. And first, it will be convenient to give a table of the greatest rises of tide, which is very different at different places, for the very same mechanical reason which makes the tides of the Bay of Fundy and Chepstow, the highest tides in the world, namely, because the great impetus with which the water flows during the rise of an equinoctial spring tide into a channel which rapidly narrows, causes the water to take in *height* what it cannot take in *breadth.* And thus, while the space between Cape la Hague and the north-western angle of Britanny is 150 miles, the tide is driven into a corner near Mont S. Michel, and so its rise becomes 54ft., whilst at Cape la Hague it only rises 20ft.

Rises of the Highest Tides in the triangle formed by Cape la Hague, Ushant, and Mont S. Michel.

	English ft.	in.
Ushant...	10	0
Near Roscoff, in longitude 4° W. of Greenwich	13	10
At 3° west longitude, on N. coast of Britanny	15	4
S. Malo	46	0
Near Mont S. Michel	54	0
At the Minquiers	47	0
At Granville	49	7
Jersey	42	0
North of the Dirouilles...	41	0
Guernsey	30	0
Cape la Hague and the Caskets, each	20	0

Approximate Amounts of Sinkings.

	Soundings at low water. ft.	in.	Above high water. ft.	in.	Rise of tide. ft.	in.	Total Sinking. ft.	in.
Bourg of Lhan Kafruth	36	0	10	0	54	0	100	0
S. Moack's Monastery	45	0	10	0	54	0	109	0
Menden Monastery	25	6	10	0	46	0	81	6
Taurac or Caurac Monastery	54	0	10	0	54	0	118	0
Mandan Monastery	33	0	10	0	50	0	93	0
					Average		100	2

But "Bourg" indicates a village or town *on a hill*, or in an *elevated situation:* and there may be seen on the sailing chart (from which our map is copied) within the space which appears to have sunk, occasional soundings of 11 fathoms or 66ft., which reckoning, as before, would give a sinking of 130ft. So that the actnal sinking may have been greater than any of those given in the table. And, at any rate, it would not be correct to take the average, because that would bring the original positions of S. Moack's and Taurac *below* the level of high water, which cannot have been the case. Ought we not rather to take the maximum, and say the sinking in the Bay of Mont S. Michel has not been less than 118ft.? And, in fact, it may have been considerably more, if Abbé Manet's statement, given in the following article, can be depended on.

104. *Ancient and modern heights of Mont S. Michel.*—Abbé Manet (p. 60) correctly describes Mont S. Michel as an euormous block of granite (the present writer observed that the rock contains shining scales of mica) he says it is singular in all respects. "N'a pas moins de 200 pieds de hauteur, sans compter ce qu'y ont ajouté les ouvrages de l'art. Les géometres qui, en 1775, dressèrent le plan de ce mont, lui donnèrent 450 toises de tour sur le grévage, 180 pieds seulement d'élévation jusqu' au sommet du roc, et *en totalité* 400 *pieds depuis le niveau de la grève jusqu'*

* See Art. 73 ante.
† Vol. 4, p. 362. And Manet p. 103.
‡ Judicael succeeded Alain le Long, who died A.D. 690, *Morery's Dictionary.*
§ Manet gives a reference, Gallet, *Mem sur l'orig des Bret. Armor.* ch. 6, n. 18.

à la lanterne du clocher; mais nous avons d'autres bonnes autorités pour les mesures que nons avons determinées. Du haut de ce panorama, dont tout l'ensemble, *dans son état primitif, avait* 565 *pieds d'élévation*, les personnes qui sont en bas ne peuvent être reconnues, et semblent autant de pygmées qui rampent à l'entour." That is to say, if Manet is correct, there is a difference between the height in 1775 and the height in its primitive state of 165 French feet, which are equal to 175ft. 10in. English. Dr. Hairby (p. 128) says that the whole height to the top of the towers is 378ft. And that a large dyke before the entrance gate [to the island] traced by the sea in 1822, exposed the end of a causeway paved with large stones, ten feet below the surface of the sand. This causeway led to the entrance gate.

If we add this 10ft. to Dr. Hairby's 378ft. we shall still have a less height than that of 1775. In Art. 71 we have the chronicler in Neustria Pia, thinking that the Mout formerly deserved the title of a *Mountain*, whereas when he wrote he conceived that it was sufficient to call it only *a rock*, as if its height as well as its length and breadth had been considerably reduced. In the margin of the text of Neustria Pia are given references to Glaber, Sigehert, Peter de Natalibus, Catalogue of Saints, S. Antonius, Breviary of Coutances, &c., which have already been quoted in Art. 78. The Sinkings have been deeper doubtless, and have extended to unknown distances seaward and thinned, perhaps to nothing, on land.

The present writer is well aware that some of his friends will say:—"we do not believe Abbé Manet's statement of its primitive height." Abbé Manet having departed this life, cannot now be asked for his authority for the ancient measure which he gives. Will the impartial reader believe that he *forged it?* Probably not. If not, there are 175ft. 10in. difference between the ancient and modern heights to be accounted for, which may perhaps be due in small part to difference in heights of buildings. For the writer observed on August 27, 1862, that the top of a small spire had been taken off. He has laid before the reader, as to the former height of Mont S. Michel, all the information he possesses, and there he must leave the matter.

Observe, if nothing had happened except an inundation caused by an equinoctical tide impelled by a strong north wind, why did not the water ebb off again, and leave the ground dry though covered with prostrate trees? Why has the Forest of Sciscy remained $11\frac{1}{2}$ centuries under water, unless because the ground has sunk? Again. From the creation to A.D. 709 is about 4,700 years; consequently there had been about 9,400 equinoctial spring tides during that period. But there are only thirty-two points of the compass, consequently during equinoctial tides, the wind must have blown from each point of the compass on an average 293 times. Therefore, there must have been a north wind of more or less force 292 times before the catastrophe happened. Why did it never happen before? Is it not the only way to explain these things—"*The ground has sunk?*"

Losses of Land on the North Coast of Britanny, farther West.

105. At two leagues west from Lannion (which is in 48° 45′ N. lat. and 3° 30′ W. long.) in the middle of a great bank of sand, called now, Grève de S. Michel, at the entrance of the village of S. Michel a stone cross was fixed on a rock, and the site of this bank of sand was once occupied by a very spacious forest. M. Ogée descrides the same forest in other words as follows:*—"*Plestin;* about 6 leagues to west-south-west of Treguier its bishopric. In the year 480, Saint Efflam arriving from Ireland his country, in Bitanny; built for the first time the chapel of his name,† which we see at this day on the border of the Grève. We are assured that the Saint descended from his boat precisely in the place where the stone cross stands, which the sea covers at every tide. The country then was nothing but a vast forest, in which this saint built a hermitsge, which they say was in the place where the chapel now is. He died 6 November, 512." I think there can be no doubt that the trees, &c. which are mentioned in the following article, as having been cast up near Morlaix (which is in the neighbourhood), must have been parts of this forest.

* Vol. 3, p. 369.

† The French Chart shows this chapel at the S. W. angle of Grève de St. Michel.

106. *Trees cast up near Morlaix.*—In the Gazette of France, February 22. 1812, is given an extract of the 179th volume of the "Journal of Mines," as follows:—"M. de Fruglaye, who was walking near Morlaix on a sandbank after a strong tempest, perceived the appearance of the sandbank changed. The fine sand which covered it had disappeared, and a black earth was seen in its place, marked by long furrows. It was a mass of vegetable remains, among which several aquatic plants were distinguished, and leaves of forest trees. Beneath this bed were rose trees, rushes, asparagus, ferns, and other meadow plants, of which many were very well preserved. Over all this earth were seen trunks of trees in every direction; the greater part were reduced to a kind of earth, and others were in a state of freshness. The yews and oaks were of their natural colour, and numerous birch trees had preserved their silvery bark. All these ruins of an ancient vegetation, buried by a sudden revolution, were placed upon a bed of clay, like that which ordinarily forms the basis of our meadows. M. de Fruglaye, this Gazette adds, has pursued his researches over a space of *seven leagues*, and always along the sandy shore he found everywhere the remains of this ancient forest buried.—*Manet*, p. 30, 31.

107. *Unfounded objections.*—A gentleman objects that the submarine trees in St. Ouen's Bay "may have drifted thither, and then sunk." This is impossible. It could not have been the case near Mont. S. Michel and Granville; nor could it have been the case in S. Ouen's Bay, because the roots were inserted in the sea bottom. M. de Fruglaye's trees were avowedly ultimately drifted upon the shore near Morlaix, but where did they come from, and how did they get to the place from which the storm removed them? Now, granted there were plenty of forests in ancient times close to the sea. But *firstly*, how does my friend get all the trees and plants rooted up and fairly afloat on the sea? *Secondly*, if he can get them fairly afloat, how does he *keep in a body seven leagues long* these thousands of yews, oaks, birches, rose trees, rushes, asparagus, ferns, and other meadow plants? *Thirdly*, supposing him to have got over these two difficulties, how does he get everything after having "drifted"—that is *floated*, for an unknown distance, *to sink and remain at the bottom for an unknown time*, until 1812? It is fair to state that the gentleman's suggestion of "drifting" was made off-hand, in the course of conversation. But though he by no means intended anything of the sort, it was in truth an attempt to explain away, in the sense of getting rid of, a piece of evidence which was unfavourable to his own preconceived views.

Trunks of Trees and Remains of Buildings found on the Shore at the North-Western Angle of Britanny.

108. In the *Histoire de Petit Bretagne ou Bretagne Armorique*, by Abbé Manet, 1834: speaking of the north-western angle of Britanny he says (Note 15 p. 19), "the ebb uncovers still at this day on the shore, trunks of trees and remains of houses." This is a point of importance and will be referred to again under the heading "Ptolemy." Because it proves that the very rigid test to which his latitudes and longitudes have been put, by reducing them to modern and laying them down on modern charts, would in the present instance if no land had been lost, have coincided exactly, perhaps, with the ancient Gobæum promontory.

CHAPTER VI.

Ptolemy, the Geographer.

109. *Biographical.* "Claudius Ptolemy, a celebrated geographer and astrologer in the reigns of Adrian and Antoninus [who reigned from A.D. 117 to A.D. 161], was a native of Alexandria, or according to others, of Pelusium, and on account of his great learning, he received the name of most wise and most divine, amongst the Greeks. In his system of the

world he places the earth in the centre of the universe, a doctrine universally believed and adopted till the 16th century, when it was confuted and rejected by Copernicus. His geography is valued for its learning and the very useful information which it gives. The best edition of Ptolemy's Geography is that of Bertius, folio, Amsterdam, 1618."—See Lempriere's *Classical Dictionary.*

110. In Ptolemy's Geography, longitude is reckoned from the west side of the Canary "Isle," which he calls zero or 0°, to the east side of the island Taprobane, or Ceylon; or according to others Sumatra,* which he calls 130°. The modern longitudes in the following table have been obtained from the English Ordnance maps. Admiral White gives (in *Sailing Directions*) the longitude of the lighthouse which is on the *east* side of Lizard Point, by chronometer, 5° 10′ 39″ and its latitude 49° 57′ 18″.

Note. There appeared to be so much doubt whether any, or if so which, points on the northerly or westerly coasts of France are unaltered at the present day; that it was thought better to take the Lizard and the centre of the Isle of Wight, of which Ptolemy gives the latitudes and longitudes under other names—as bases or points of departure. And by that means to reduce his points on the French coast to modern latitudes and longitudes, for the purpose of laying them down on a chart. The first part of the following series of Ptolemy's longitudes and latitudes is from Bertius's edition of Ptolemy's Geography, 1618; and the last part from the Lyons edition, 1535.

—	Centre of Lizard Point.	Centre of Isle of Wight.	Differences.
	° ′	° ′	° ′
Ptolemy's Longitudes ...	12 0	19 20	7 20
The Modern Longitudes are	5 12½ W.	1 18⅓ W.	3 54⅙

Thus, according to the Ordnance Maps, 7° 20′ of Ptolemy's longitude corresponds with 3° 54⅙′ of modern longitude, and is reckoned in a contrary direction. Hence it follows that:—

1° of Ptolemy's longitude is equal to 0° 31·9316 Modern.

1° of Modern longitude is equal to 1° 52·7402 Ptolemy.

His meridian of Greenwich becomes 21° 47·18.

Latitude.

110. Ptolemy reckons latitude as is done at the present day, namely, from the equator as Zero, northwards. He makes the south coast of England *farther north than its true position,* and consequently the latitudes of his various positions on the French coast have been made *farther north in the same proportion.*

The Lizard has perhaps not altered much, *in longitude* since Ptolemy's time (but it may have altered, *in latitude,* as we shall see), being of the rock called Serpentine, a very hard material. But there may have been a wasting away of the Isle of Wight, which if it has been equal on the east and west, would leave the longitude of the centre of the Island exactly in the same spot where it was in Ptolemy's time. And since the eastern and western extremities of the island are of the same geological material, it has not been thought necessary to make any allowance in longitude for irregular waste. But a different course has been pursued with regard to the *south* coast of the island as regards latitude, because being much more exposed than the *north* coast, it has probably wasted considerably more. And the 40″ of the modern latitude of the centre of the island given in the following table has therefore been cancelled. That is to say, a waste of a fraction of a yard annually on the south coast more than on the north, is assumed by the present writer, to have taken place on the average, ever since Ptolemy's time. And for that reason, the Modern latitude of the centre of the Isle of Wight is taken as 50° 39′ instead of the 50° 39′ 40″ given in the following table as obtained from the Ordnance Map:—

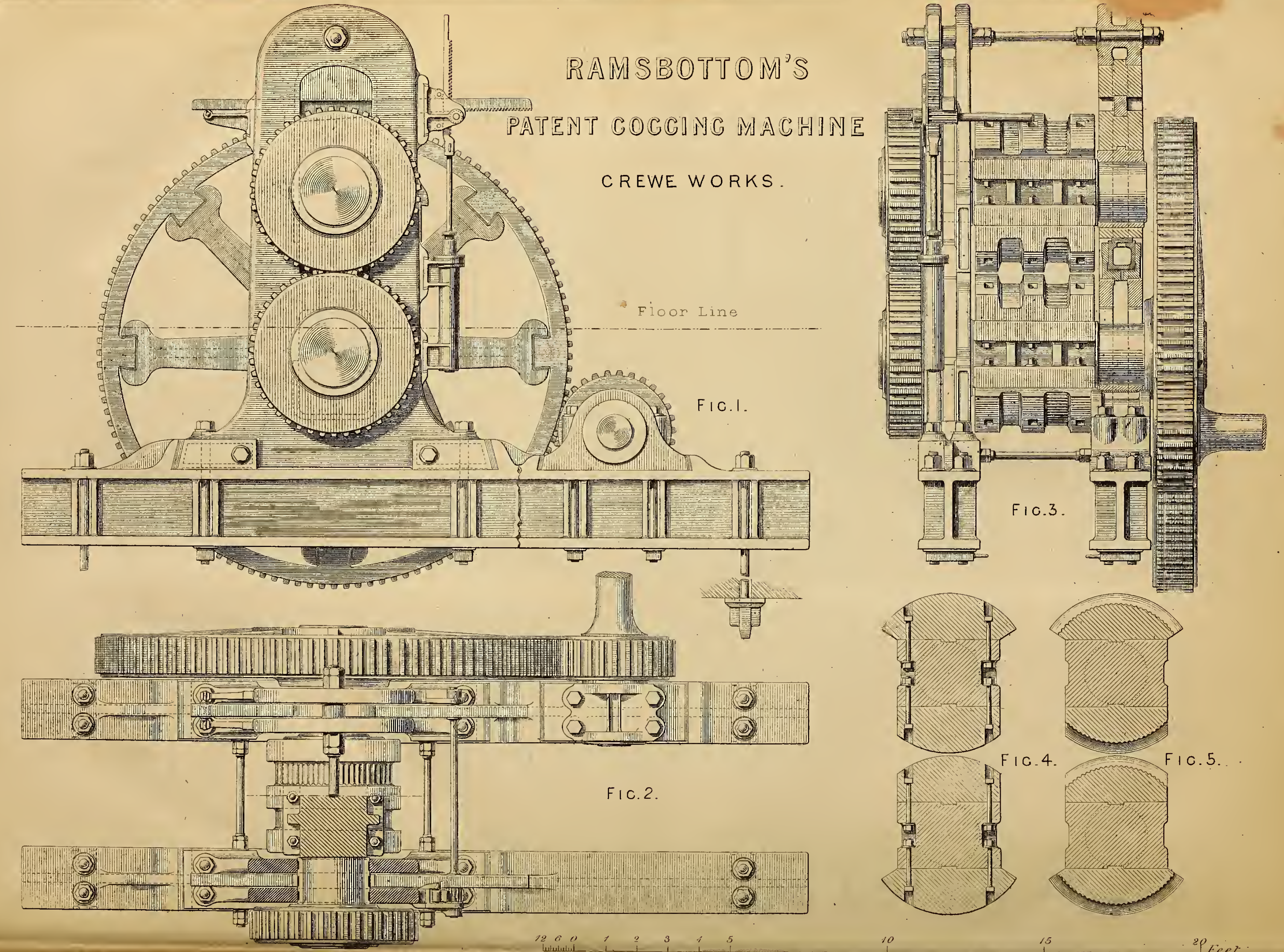
—	Lizard Point.	Centre of Isle of Wight.	Differences.
	° ′	° ′ ″	° ′ ″
Ptolemy's latitudes North of Equator	51 30 0	52 20 0	0 50 0
Modern latitudes (Ordnance)	49 57 28	50 39 40	0 42 12
			0 7 38

From several authorities quoted in the next paragraph and subsequently it is probable that there has been a good deal more wasting and *sinking* on the south coast of Cornwall than at the Isle of Wight, and therefore the 50° 39′ has in the following Table always been used as equivalent to Ptolemy's latitude of the centre of the Isle of Wight in his time, and the *latitude* of the Lizard has not been used at all for the purposes of calculation.

Sir Henry de la Beche in Chapter XIII. of his *Geological Report o Cornwall, Devon, and W. Somsrset,* gives about twenty-five pages of very interesting details as to changes of level, &c., and quotes his authorities, for which the reader is referred to the work itself. It is sufficient to prove the allegation just made as to the wasting and sinking, to quote his summary from p. 420 of his valuable book. He says:—"Taking the general evidence afforded by the so-called submarine fossils round the shores of Devon, Cornwall, and Western Somerset, we find that a vegetable accumulation, consisting of plants of the same species as those which now grow freely in the adjoining land, is frequently discovered occurring as a bed at the mouths of valleys, at the bottom of sheltered bays, and in front and under low tracts of land, the seaward side of which dips beneath the present level of the sea, so that the terrestrial vegetation forming those parts of the bed could not have grown at their present levels. Now, as there appears to be the very best evidence that numbers of the roots of trees occupy the situations where they grew relatively to the subjacent ground, and *as these roots are to be often traced as far as the tides recede even at the equinoxes,* we seem compelled to admit that a change in the relative level of the sea and land has taken place since these trees lived on the situations where we now find them." Mr, Pengelly, F.R.S., too, in the report of his paper read at the Bath meeting of the British Association, "On changes of relative level of land and sea in south-eastern Devonshire, In connection with the antiquity of mankind." After having briefly noticed the characteristics of the existing general coast-line, he described a series of phenomena which, indicate that "within what is known as the Quaternary Period, the whole of south-eastern Devonshire was at least 280ft. lower than at present; that by a series of slow and gradual upheavals, separated by protracted periods of intermittence, it was raised at least 40ft. above its present level; that these elevatory movements *were followed by one of subsidence.*"* Now it has been supposed by some, that the pre-historic human remains, or pre-historic remains of human art, which have been detected upon or among strata so raised or depressed—give some indication of the *period* of such elevation or depression. And the idea has even been entertained, that the presence of pre-historic remains indicates pre-historic risings (or sinkings). It would be a curious coincidence, and one which we have no right whatever to assume; if the remains in question had been deposited by chance or intention, *immediately before the time* of a rising or sinking. It is infinitely more likely that pre-historic remains have been deposited in pre-historic times, and that they have risen and sunk again and again with the land since. And we shall see in Art. 133, that changes of level took place on the south coast of Cornwall, as lately as the beginning of the 9th and end of the 11th centuries; which *render it probable* that the position of the Lizard is farther north now than it was in Ptolemy's time. Which was obliged to be assumed if Ptolemy's positions were to be used at all—and which has accordingly been assumed,

* See Sir E. Tennant's *Nat. Hist. of Ceylon,* p. 67.

* "British Association Report," 1864. Transactions of the Sections, p. 63.


RAMSBOTTOM'S
PATENT COGGING MACHINE
CREWE WORKS.
Floor Line
FIG. 1.
FIG. 2.
FIG. 3.
FIG. 4.
FIG. 5.
12 6 0 1 2 3 4 5 10 15 20 Feet

to make his latitude of the Lizard consistent with his latitude of the centre of the Isle of Wight.

111. Ptolemy thus treated (consider Art. 112 in connection with this) puts the coping-stone on what has heen bcen stated in Chapter V. His mouth of the river Argenis, which was, of course, a point in the ancient coast-line, falls *seventeen miles west* of the presnt coast of Normandy. And the mouth of his river Tetus (another point in the ancient coast-line). falls *more than* 30 *miles west* of the present west coast of Normandy, And I think leaves no doubt that Jersey was an integral part of the continent in his time. The writer has wished to be moderate iu exhibiting restorations of the supposed aucient coast-line in the map, and he has therefore treated the mouth of the river Tetus as a broad estuary, rather thau exhibit the river of narrower dimensions, and (by consequence) the loss of land as having been greater. He helieves the Tetus may have been one of the estuaries referred to by Cæsar in the third book of his Gallic War, as will be explained hereafter.

112. Ptolemy's Gobæum Promontory of the Osismii falls very near the north-western angle of Britanny, especially if we allow for the loss of laud stated hy Abbé Manet (Art. 108) to have taken place there. His Harhour of Staliocanus is almost identically in the same position as the present Harhour of Portrieux. There arc other statements which tend, so far as they can he depended on, to confirm Ptolemy's position of the mouth of the river Argenis. Namely:—*First*, Mr. Ahier (now deceased) states at p. 98 in the volume quoted hefore, that Mont S. Michel was "at ten leagues from the sea." But when asked personally he did not remember what was his anthority. *Second*, M. Bonnissent (quoted hefore) states in his pamphlet, that Mont S. Michel was left "en pleine forêt, à dix lieues de la mer." I have not been in communication with him and could not ask his authority. *Third*, Lecanu p. 21, says "c'est une autre tradition que le Mont-Saint-Michel était éloigné de plusieurs lieues de la mer, Thomas Leroi l'a inscritc dans ses *Curieuses Recherches*." It may be that the reader has now before him at one and the same time, both the tradition and its *origin*, namely the position of the mouth of the River Argenis; which is nearly "ten leagues" (French) from Mont S. Michel.

113. The left hand column of the table (to he given presently) gives Ptolemy's latitudes aud longitudes of the various places named by him in the centre column; and the right hand column gives the corresponding modern latitudes and longitndes (always west of Greenwicb) calculated on the principles aforesaid. The present writer's statements and remarks are placed between hrackets thns [ ]. It is remarkable that some of Ptolemy's positions are very difficult to understand and that he takes no notice of any island near the French coast; though Pliny the elder (died A.D. 79) who lived near a century earlier, mentions that there were in his time "nearly two huudred islands of tbe Veneti" between the Seine and the Pyreuees. There are other ancient references to some of these islands as will be seen in due time.

Note. 2° 20′ 22″ added to longitudes west of Greenwich give longitudes west of Paris. See Herschel's *Outlines of Astronomy*, 1864, p. 60.

Plate 307 shows, amongst other things, Ptolemy's positions given in the following tahle, approximately. The text of the table gives the description and distances from well known points and places correctly, as taken from the large scale charts of the French Government. The conclusion I arrive at is, that Ptolemy's figures are sometimes corrupt, and not as he wrote them. For he is clearly correct in some cases as for instance, where he fixes Gobæum promontory and Staliocanus Harbour correctly, relatively to the Isle of Wight (Vectis) and the Lizard (Ocrinum) though there are a hundred English miles of sea between. Though he had neither a quadrant nor a chronometer, it is clear he had some means of fixing latitudes and longitudes with appropximate correctness, independently of actual measuremeuts which, of course, he could not make all the way across the Euglish Channel. It is incredible that he who could fix the places mentioned, so well, should have made such gross blunders as to place the Harbour Vindana and the mouth of the Seine, each many miles in the interior of Gaul. To suppose that some of his figures have heen corrupted, would account for the false positions of the two last-named places. Whether he is right with respect to his former coast line on the eastern side of the Bay of Biscay, which he places a whole degree west of the present coast; I must leave to each reader's own judgment. Remarking only two things. First, if his coast line is rigbt, some of the "almost two hundred islands" of the Veneti must have been farther out into the bay than his coast line. And second, it is very remarkable that all his positions between the Isle d'Yeu and the Pyrenees are *uniformly far west* of the present French coast. With respect also to his British promontory Antœuestæum or Belerium, which he places far out in thc Bristol Channel, we shall have farther lights on the subject by-and-by.

AN EXCURSION TO THE CREWE LOCOMOTIVE WORKS.

By J. J. Birckel.

(*Illustrated by Plate* 306).

We now bring this subject to a close by giving a description of what is termed at the Crewe works, a "coggiug machine," which we have illustrated upon the accompanying plate, and which has been desigued for the purpose of roughing down large ingots of steel, or blooms of iron.

The machine consists principally of two large segmental rolls resting in two vertical side frames bolted and keyed upon two horizontal beams firmly secured to a heavy foundatiou of masonry, a considerable portion of the machinery being below the floor level, so that the top of the lower roll is 1ft. 2in. above this level.

The rolls are about 5ft. diameter, and are built up of an axle and two segmated blocks bolted to the same; these blocks may be provided with grooves of any required section, and those shown in our illustration are prepared for rolling square ingots on the flat, and being only bolted to the axle they may be easily replaced when worn out, or when a different section of grooves is required;—the bearings of the rolls are 2ft. in diameter, 1ft. 6in. long, and 5ft. 5in. apart from centre to centre.

The axles of the rolls are furnished at one end with pinions of equal size, gearing into each other, and that of the lower roll carries at its other end a spur-wheel 15ft. in diameter, which receives its motion through a suitable train of gearing, from a horizontal engine with two cylinders, 17in. diameter, and 1ft. stroke, working at an average pressure of 60lbs.

Tbe motion of the rolls is reversed by reversing tbe engines, and as the speed of the latter is very high compared with that of the rolls, this is easily accomplished by a lad who, by means of a couple of handles, holds the cntire machine under his control, and being stationed at some distance out of sight, causes it to perform its work like an automaton.

The journals of the upper roll are furnished with brass bearings, both above and below, carried between cast-iron caps or bearings. The lower ones rest upon the rams of two small hydraulic presses placed one in each frame, by means of which the distance of the rolls may be regulated at will, in the following manner:—

A wedge is inserted between the caps of the upper brasses of each of the bearings of the upper roller and the side frames, and when the wedges are drawn forward, the rams of the hydraulic presses below are forced down and the rolls are brought closer together. The wedges which terminate at one end in the shape of a rack, are worked by means of a hydraulic press whose ram also carries a rack at its extremity, which in its upward movement communicates a rotary motion to a shaft supplied with pinions gearing into the rack of the wedges, which are thus drawn forward, whilst by the downward motion of the ram they are pushed backward; in this case the space between the rolls is widened, the pressure in the hydraulic presses under the bearings of the upper rolls being rather more than sufficient to balance the weight of the roll, and as that in the hydraulic press working the wedges is able to overcome thc pressure in the former, the relative position of the roll is therefore entirely controlled by the combined action of the presses.

The lower rolls, as a matter of course, are supplied with brasses on the under side of the bearings only.

The segments of the rolls may be turned up in their places in the ordinary way, by fixing slide rests to the side frames against which provision is made for the purpose.

Instead of being provided with grooves, as in the example illustrated, the rolls may be made with recesses corresponding in shape to any forging of which a number are required, when these may be produced by working the rolls backwards and forwards, as many times as is required to squeeze the forgings into their final shape.

The accompanying woodcuts (figs. 1 and 2) illustrate the apparatus for shaping regulator scrolls, as described in "The Artizan" of August last.

Fig. 1.

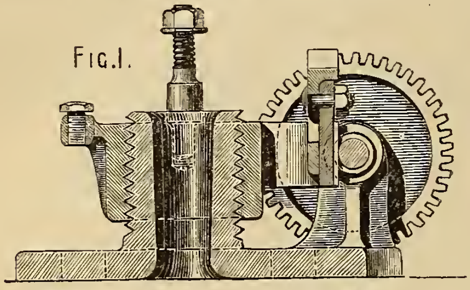
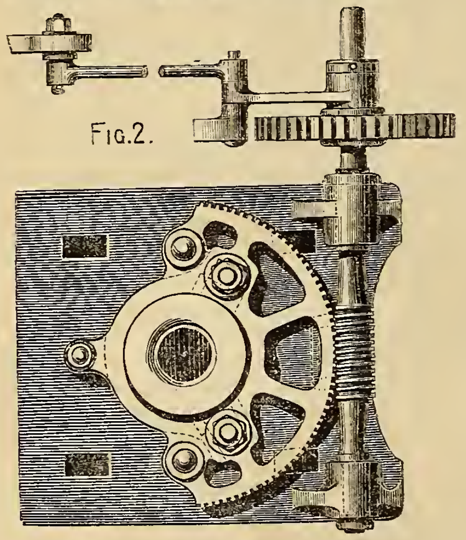


Fig. 2.



SHIPS, COMMERCIAL AND WAR.

By William Eathorne Gill.

(*Continued from page* 222.)

If we turn to the navy, we can see extensive and expensive experiments necessarily perpetuated. Major Palliser has sent his chilled shell of 250lb. weight "clean through" 8in. of iron armour and 18in. of teak backing. No ship of present dimensions can be put to sea with success when "hampered" in armour of 8in. thick. So, then, our guns can send shot or shell to penetrate the vaunted armour, as our smaller guns penetrated the old wooden ships—aye, "clean through." But ships cannot double their "top weight" at pleasure, and remain seaworthy. Therefore, we may have to give up our ideas of ships, and come to floating batteries, to be constructed on those principles which their form and use suggest. Other naval tactics than those which led a host of Nelsons and Howes to victory have to be invented—possibly among the dying and the dead—for we must still be victors. Our "hardy tars" may give place to artillerymen; no masts, no yards, no sails will be needed, when steam usurps their functions. Guns, and the expert use of them, will be the great requirement in naval battle. The gallant daring exhibited aforetime when boarding an enemy must give place to some other feat of courage and skill, for the old track is becoming more and more impracticable.

It may be that we are not driven to the necessity of throwing overboard our present expensive fleet—to construct other ships at a greater expense. It may be possible to improve the power of resistance of the ships we have, and that economically and efficiently. It may be found that we have not exhausted our resources in that direction until after trial of case-hardened armour-plates. The process is simple, and well known. As this hardening occurs on the surface only, it would leave the remainder of the thickness of the plate to become a suitable and additional "backing" to cushion the hardened-steel-like face. This process could be adopted whenever an armoured ship came under repair, for her old plates can be so treated, as new ones must be, after all holes are cut or drilled, and before fastened in their proper place. The cost must be insignificant. Experiment can decide the preference for both, or only one, of the faces of the armour-plate to be so treated. We sometimes see the word "difficulty" in print; but few men appreciate it less than Englishmen.

IRON SHIPS' BOTTOMS.

By William Eathorne Gill.

The encouragement given to Mr. Daft by the late First Lord of the Admiralty has now elicited the capability of zinc to preserve the bottoms of iron ships from fouling. This fact cannot be too highly estimated, when iron ships are on the increase, and, in point of fact, superseding the wooden ships. The subject was brought before the British Association by Mr. S. I. Mackie. The President of the section (Mr. Hawkesley, C.E.) very appropriately illustrated our present position in his remark, that "the engines of iron steam vessels which crossed the Irish Channel performed about 4,700 revolutions when the vessel was clean, and in about six weeks they made 5,200 revolutions over the same ground, occasioned by the accumulation of weeds, shell-fish, &c. In some of the vessels in the West Indies no less than three-fourths of the steam-power, and of course the coals to generate it, was spent in overcoming the resistance of this foulness." Accepting the new facts as stated, the President suggested, "instead of covering the bottom with sheets of zinc, the interstices between the plates of iron be filled up with zinc, instead of wood. By this means the galvanic action would be kept up at a far less cost." This idea of economy might be carried a little farther, by accepting the method of Sir Humphrey Davy, of bolting slabs of zinc on the iron bottom—say, three on each side of the ship; and we may trace out this line of argument to its consequences, thus: The galvanic action produced when the ship was in sea-water was found sufficient to prevent erosion of the copper when iron slabs were bolted on it, and to encourage the growth of sea-weed on the now negative copper.

It is amusing to remember that the sailor and the philosopher came to diametrically opposite conclusions on the merits of that experiment, and yet both were strictly correct, from the point of view of each. Now, we all know that iron is positive to copper, and so is zinc positive to iron, and that there is a great difference in their relative activity, and that galvanic action can therefore occur with iron protected by zinc; but, if only protected and not covered then we have the galvanic action operating in the wrong direction for the cleanliness of the ship. In fact, we open a still more fertile field for the luxuriant growth of seaweed, on the negative iron surface. It follows then, that the surface must be covered with the zinc sheathing, or the difficulty complained of will remain, if not positively increased by an improper use of zinc. Zinc, like copper, is slowly eroded by sea-water whilst being now relatively positive, its tendency to do so, is slightly increased by galvanic action. The zinc now parts with its oxidised surface-film, more freely and the sea-weed and the shell-fish, which are prone to adhere to it, are washed off in embryo together, whilst the iron is preserved at the expense of the zinc sheathing, saving the ship. If a sheet of tarred paper or felt were introduced between the iron and zinc, vegetation, by infiltration, would be held in check.

A NEW SYSTEM FOR WORKING HEAVY GUNS.

We give an illustration of a very beautiful iron model of a naval gun-carriage and platform now under exhibition at the Agricultural Hall, Islington, which we deem well worthy the notice of both naval and scientific men. Regarded only as a mechanical arrangement, this gun-carriage possesses unusual merit, evidencing not only simplicity of design, hnt it further shows us how a clever mechanical adjustment can be turned to most profitable account hy superseding manual labonr.

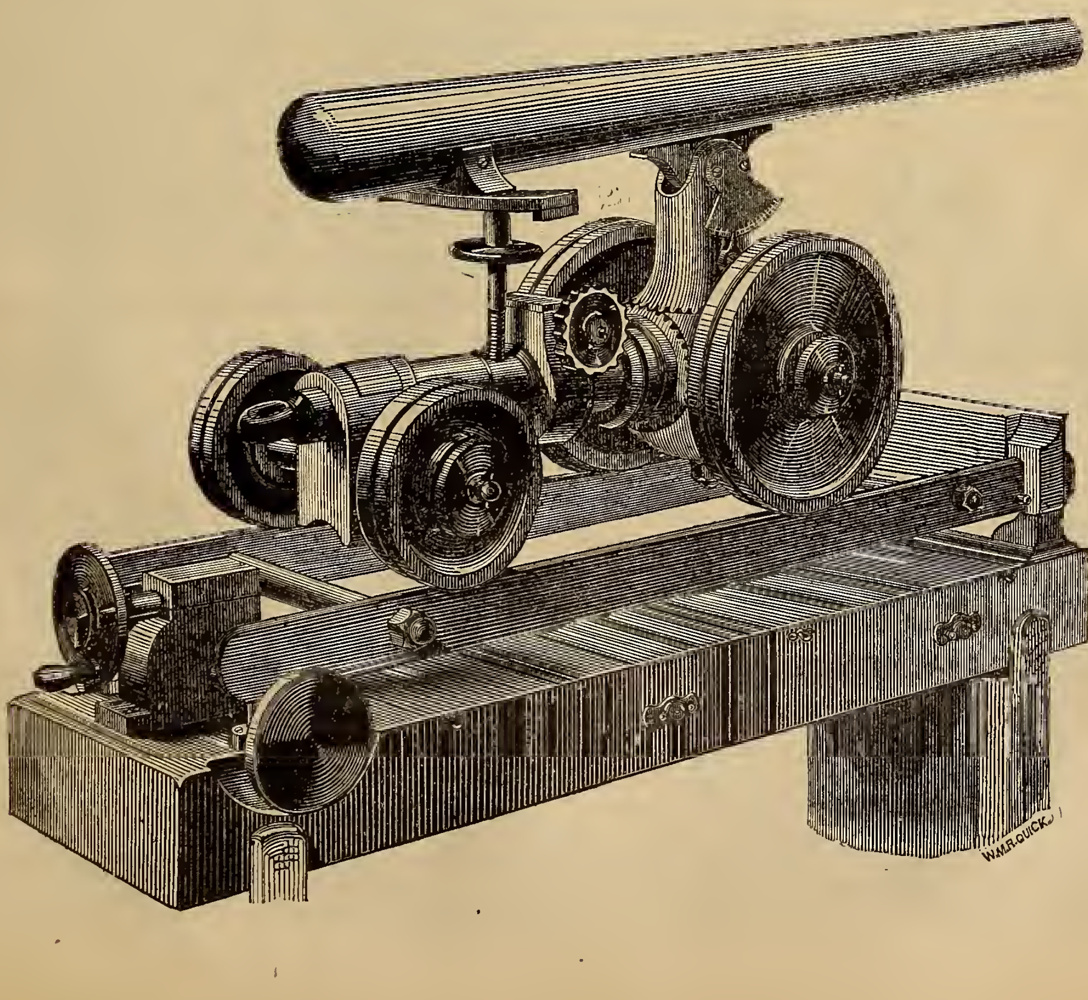
In the *Times* of Angust 5th, 1864, reference was made to the snbject of working heavy broadside guns as follows:—"In the opinion of all officers whose views on the snbject are worthy of consideration, the present mode of working large guns by the old system of tackles and handspikes is a disgrace to the age, and, nnless some simple and easily-workable mechanical arrangement can be adopted for the monster 12 and 15-ton guns, it is believed that the working of those guns will prove a practical impossibility."

Science and art step in, dispelling all apprehension on this point, and offer their aid to supply so important a desideratum—namely, that of efficiently working and having nnder perfect control guns weighing 15 tons and upwards. This problem has heen most successfully solved by Mr. Wm. Hewitt, of Bristol, who is the inventor and exhibitor of the new system for working heavy guns. Mr. Hewitt's invention is both novel and simple in the extreme, inasmuch as it dispenses with ropes, blocks, tackles, handspikes, winches, slides, endless chains, friction-rollers, compressors, tnrntables, hydraulics, and steam-power. The invention is just what the *Times* asked for—viz., a simple mechanical arrangement, which is embodied in a gun-carriage and platform, both of enormous power and strength.

To work the monster 12 and 15-ton guns by the old system it required no less than 19 men (see the *Times*, June 8th, 1865); this important and valuable invention reduces the labour to *one* man, who can run *in* and *out*, point, elevate, and depress a guu of 15 tons and upwards, with a facility and precision hitherto unattained. In fact, the arrangement altogether is so simple that a few minutes' instruction would make any ordinary Jack Tar perfect master of the same. The provision made for the gun's recoil is also of a novel and simple character, "being self-acting," and will admit of nice adjustment.

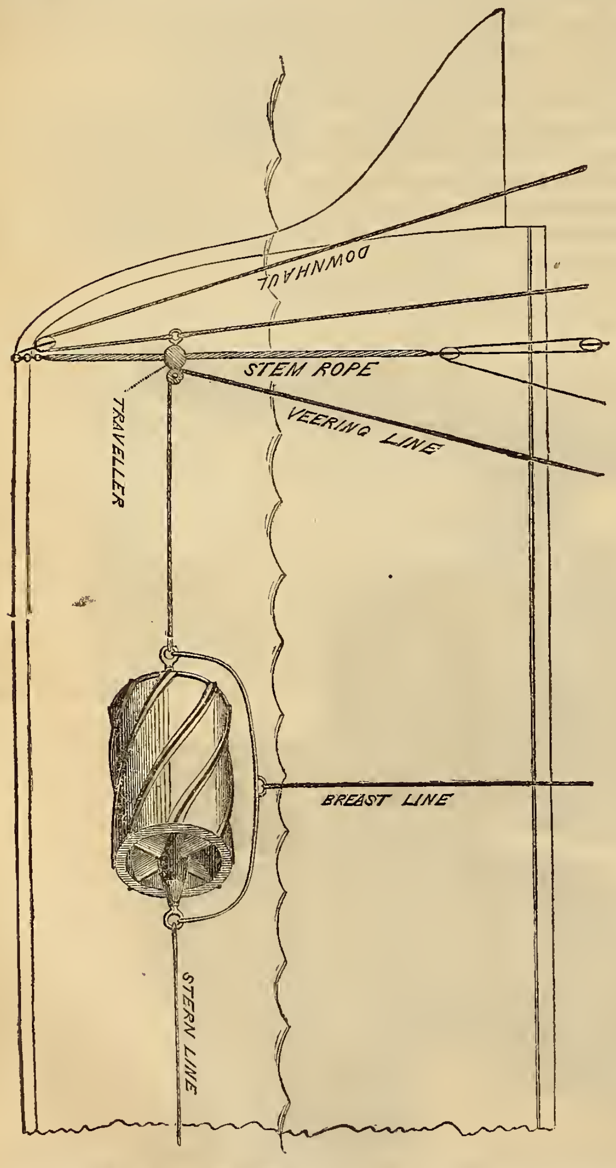
The following is hriefly the principle on which it works. The weight of the gun and carriage, which latter travels on a ∧ shaped railway, unassisted runs it in and out. This is ingeniously accomplished by means of an eccentric which either elevates or depresses the railway; more than this, the gun, by a most simple contrivance, is made to traverse a space of 25 degrees to the right hand and the same to the left, without the aid of handspikes, and this is done to all appearance (for we have seen and worked the model ourselves), with as much ease as one would wind up his watch.

The indices, which are self-recording, show at all times the line of fire and elevation,—a vast advantage for siege purposes when firing in thick smoke, or even in the dark. The model hss been inspected by a large number of scientific gentlemen (inclnding naval and military) all of whom pronounce it a most successful, invaluable, and humane invention. The adoption of this invention into the navy would secure an enormous saving to the country.



PHILLIP'S PATENT ROTARY CYLINDER FOR CLEANING SHIP'S BOTTOMS.

This machine, of which an illustration is given here, consists of a timber cylinder revolving on an axle, the turning power heing derived from the tide, or current of the ship's headway acting on spiral hlades, forming a screw within. The cylinder is armed externally with diagonally-fixed scrapers, squeegees, or hrushes. Inside it carries a screw; the action of the water ou the screw turning the cylinder either hy the running through of the water or the passage of the ship through the water, and bringing the hrushes or scrapers to hear on the hottom of the ship. An arrangement of light chains and ropes gives a certain means of moving the cylinder upwards and downwards, or forward and aft, as required in cleaning the ship's hottom. So far as any judgment may he formed at present of the capabilities of this invention, it certainly appears that no ship supplied with them need ever he allowed to have a foul hottom, or, having one, the means of cleansing it is certain, and but the work of a short time.



The Phillips Cylinder has heen tried on the bottom of the iron screw yacht *Hairy* at Portsmouth, when steaming at the rate of five knots per hour, and Chief-Inspector Murdochs reports that the experiment was attended with the utmost success.

THE NEEDLE LATCH AND THE NEEDLE LOCK.

We have heard a great deal of the needle-guu, but the needle-latch and needle-lock rather takes us hy surprise; we know that we have locks enough and to spare, locks comhining what we would call the climax of mechanical ingenuity and complicity, hut extravagant as regards price, and locks so cheap that one wonders how it is possihle they can he made for the money, hut while the latter are so thoroughly destitute of the principle of unpickahility, they are to a certain extent worthless, the former are so unreachahle hy the million as regards price, and some so delicate in their mechanism that an untoward touch knocks them out of joint, and makes them unworkahle. We hail with satisfaction, therefore, a lock which combines security with durability and cheapness. Has the lock on the needle principle all this? We have seen it, examined it, and must confess that we are struck hy its appearance. The needle-lock involves a principle we have never seen employed in locks; we have seen tumblers and levers, tumhlers with springs, and levers with springs, hut the needle requires no springs, it is tumhler, lever, and springs all in one. That it is simple in its construction is also heyond a douht as it is composed simply of steel wires—needles—strung together, as it were, on two stumps attached to the running holt upon which they revolve, which require to he lifted hy the key to a position to admit of their heing passed through certain holes iu a plate of hrass, and thus passing carry the running holt with them, which carries the real holt. The needles are elastic in themselves, heing made of the best steel thoroughly tempered, and from their position on the stump they are rendered trehly elastic, as there is elasticity at three points, indeed, therein consists the strength and unpickability of the lock hecause, uulike levers which have only an up and down movement, and always move to a point direct to the lever stump, the needles move obliquely, perpendicularly, laterally, and, indeed, in any direction, hence the difficulty in raising all the needles simultaneously, with an instrument, to their required positions to run through their own apertures, and escape the many traps set up for them in the shape of a numher of holes pierced nearly half way through the fence plate, of the exact size to fit the needles. In the more expensive latches—as we have only heen descrihing the cheapest one—there are protectors and detectors, for instance No. 3 lock is constructed on the principle that the introduction of an instrument other than its own key, on heing brought into contact with the running holt, or even raising any oue needle higher than its own hole, upsets the lever plate, which on heing upset lays hold of the running holt, and thus completely ohviates any further attempt to unlock. There is another feature in the invention which is of considerahle importance to those requiring to he out of doors during the night, as hy introducing the latch-key and turning it the converse way, the lock is throwu out of gear effectually,—the needles loosened, the fence plate capsized, and the holt seized immediately ou the introduction of the key, and moving it in the direction of the needles, the fence plate starts up, the needles are arranged, and with the greatest precision passed each through its own aperture. The latches are novel, good, and cheap, and we wish the Patent Unpickahle Lock Company every success in their undertaking.

INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution of Civil Engineers have awarded the following Premiums, for papers read during the sessiou 1865-66:—

1. A Telford Medal, and a Telford Premium, in Books, to Richard Price Williams, M. Inst. C.E., for his Paper "On the maintenance and Renewal of Permanent Way."
2. A Telford Medal, and a Telford Premium, in Books, to John Grant, M. Inst. C.E., for his paper, "Experiments on the Strength of Cement, chiefly in reference to the Portland Cement used in the Southern Main Drainage Works."
3. A Telford Medal, and a Telford Premium, in Books, to Edwin Clark, M. Inst., C.E., for his paper on "The Hydraulic Lift Graving Dock."
4. A Telford Medal to Sir Charles Tilston Bright, M.P., M. Inst. C.E., for his paper on "The Telegraph to India, and its Extension to Australia and China."
5. A Telford Medal, and the Manby Premium, in Books, to Robert Mauning, M. Iust. C.E., for his paper "On the Results of a Series of Observations on the Flow of Water off the Ground in the Woodburn district, near Carrickfergus, Ireland; with Rain-guage Registries in the same locality, for a period of twelve mouths, endiug 30th June, 1865."
6. A Telford Premium, in Books, to William Humber, Assoc. Inst. C.E., for his paper "On the Design and Arrangemeut of Railway Stations, Repairing Shops, Engine Sheds, etc."
7. A Telford Premium, in Books, to George Rowdon Burnell, M. Inst. C.E., for his paper "On the Water Supply of the City of Paris."
8. A Telford Premium, in Books, to William Ridley, for his paper on "The Grand River Viaduct, Mauritius Railways."
9. A Telford Premium, in Books, to Theodore Anthony Rochussen, Assoc. Inst. C.E., for his paper "On the Maintenance of the Rolling Stock on the Cologne-Minden, and other Prussian Railways."
10. A Telford Premium, in Books, to William Hemingway Mills, M. Inst. C.E., for his paper on "The Craigellachie Viaduct."

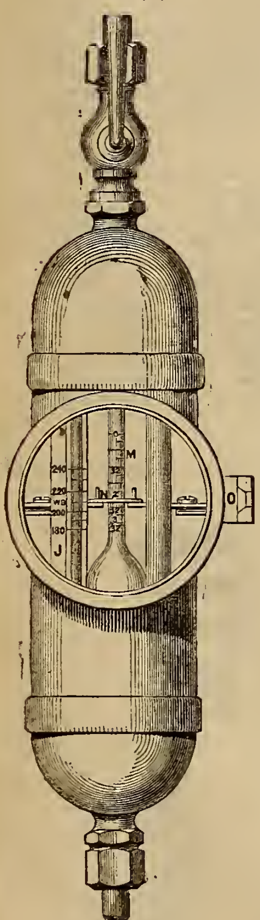
SAUNDERS' PATENT SALINOMETER.

In the rapid strides which have been made within the last few years, in the march of improvements in land and marine engines and boilers, the salinometers hitherto generally used have not been found to answer fully all the purposes for which they were originally designed. A simple, efficient, and a durable self-acting salinometer has long been an acknowledged want.

It cannot be too strongly urged upon both the users and the owners of steam power that a proper attention to the density of the water in boilers when at work tends greatly to their preservation and safety, and economy in working, as well as the saving of fuel and expenses of repairs.

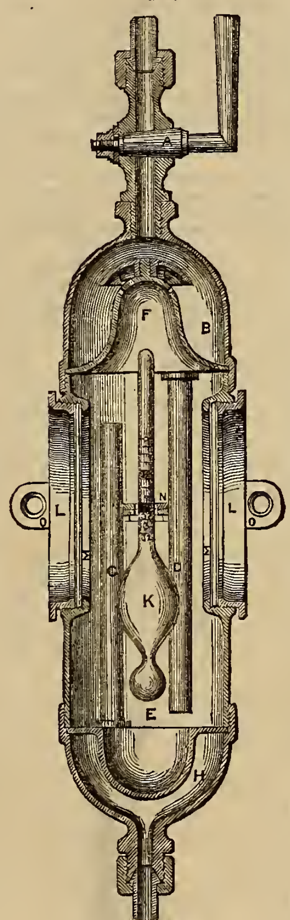
The instrument under notice has been designed from the practical experience of the failings of other instruments invented for the same purpose, and much care and expense have been incurred in perfecting it so as to attain the object sought, viz., a thoroughly efficient yet simple instrument at a moderate cost.

FIG. 1.



ELEVATION

FIG. 2.



SECTION

The principle on which this salinometer has been designed will be readily understood from the following descriptive particulars and the accompanying woodcuts, Fig. 1 being an elevation, and Fig. 2 a section of the apparatus:—

The water from the boiler is admitted through the straightway, cock A, which is the only part of the instrument that requires any adjustment, and must be set so as to allow a small stream of water to be continuously passing from the boiler through it without creating any disturbance of the water in the centre chamber E where the hydrometer K floats. The pipe from this cock should be connected with the boiler at about or a little above the height of the crown of the furnaces.

The perfect separation of the steam from the water, which has not been attained by any instrument yet invented, and without which no salinometer can indicate truly, is effected in this instrument in the separating chamber B by the water striking against the disc C, which breaks and disperses it over the chamber, and effectually separates it from the particles of steam it may contain. The water then passes through the inlet pipes D into the centre chamber E, and all ebullition is entirely prevented by means of the holes in the dome F, which connect it with the separating chamber B. The overflow water passes down the outlet pipes G through the bottom or discharge chamber H into the bilge, drain, or other convenient place.

The thermometer J is attached by means of spring clips to one of the inlet pipes D, and it or the hydrometer K are completely protected from harm, and can be readily taken out for cleaning or otherwise, and replaced by simply unscrewing by hand one of the glands (L) and removing the glass face (M), this can be effected in a minute, as the joints are made with india-rubber rings on each of the glass faces M.

The hydrometer K is read from the top of the bar or guide N.

The salinometer can be fixed either on the boiler itself or in any convenient place near, by means of the bracket O, and being completely enclosed no one can possibly be scalded by it, and it is entirely self-acting; and after once adjusting the straightway cock (A) it will work for months without further attention, and giving as it does a constant index of the state of the water in the boiler, the quantity and proper time to blow off is arrived at to a nicety, and there is no inducement to neglect or omit the regular examination of and giving proper attention to the density of the water in the boiler, which is too often the case, as well as being by the ordinary method a great interference with other duties, and at the same time an unpleasant and tiresome operation.

GENERATION OF STEAM POWER BY GAS HEAT.—JACKSON'S PATENT.

A new method of generating steam power, which combines cleanliness, safety, and facility of management, has been patented by Mr. Jackson. The furnace is fed with gas combined with atmospheric air, and being instantly kindled or extinguished by turning the gas on or off, the pressure of steam is regulated with perfect ease. It is peculiarly adapted for warehouses, or other situations, where steam power would otherwise be forbidden by the danger of fire (as the insurance companies, we understand require no extra premium on its adoption) and also where room is valuable, as the space occupied is very small. The generator represented in the accompanying wood-cut being 4 horse-power. Fig. 1 is an elevation, and Fig. 2 is a section of Mr. Jackson's apparatus.

FIG. 1.

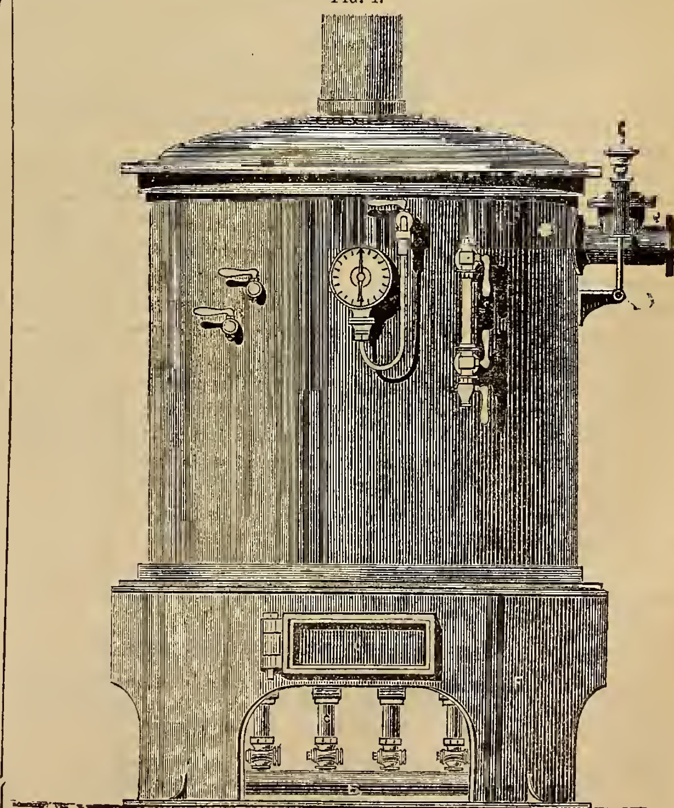
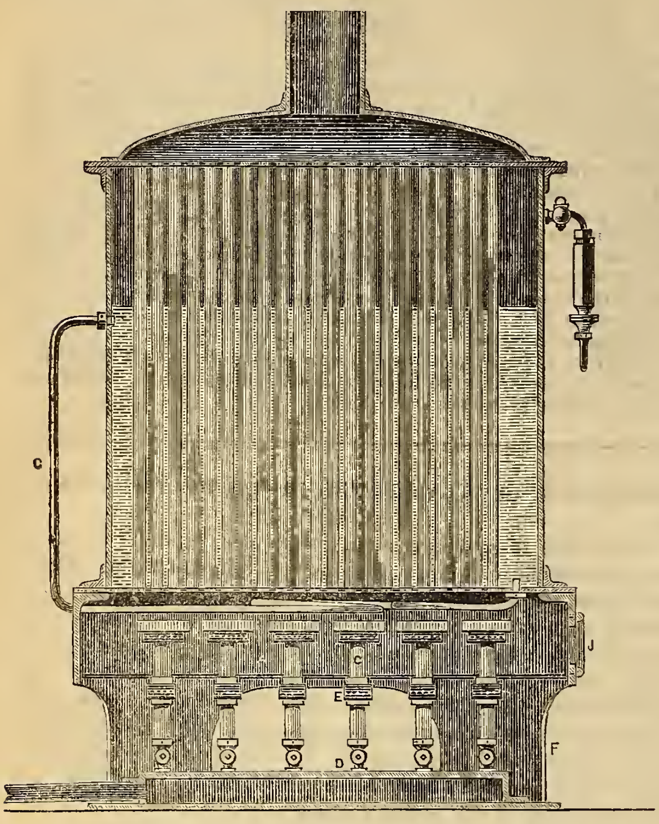


Fig. 2.



A, is the gas furnace; B, gas chamber; C, gas burners, with clay discs on surface; D, cock; E, valve for admission of air; F, pedestal containing furnace and supporting boiler; G, tube for the circulation of water; H, waterline; J, furnace door of glass or mica, whereby the furnace can be inspected without opening, and the gas regulated, either by the separate cocks; DD, which are all outside or by tho maincock, and thereby avoiding the admission of cold air.

The following are a few statistics of a boiler 2½ horse-power, with regard to the power of evaporation,—diameter 2ft.; 16 gallons of water evaporated in one hour and twenty-six minutes; expenditure of gas, 200ft.; range of pressure, 55lbs. to 65lbs.; heat passing out of chimney, 300°; generation of steam, 4lbs. per minute. These results are very satisfactory, though the inventor does not, of course, pretend to compete with coals on a large scale. When tbe engine ceases working, steam can be kept generating for a farthing an hour per borse-bower.

A half horse-power boiler furnace and engine on this principle, altogether occupying comparatively a few inches square, is working daily in the shop window at 46, Blackfriar's-road. Its duty, though intermitting, is pretty constant for fourteen hours, and the expenditure of gas is, we are informed, only 2s. per day.

The advantages are so obvious that we doubt not its being resorted to in a most general manner.

PROPOSED ENGINE COUNTER-LOG FOR STEAMSHIPS.

We have pleasure in noticing the engine counter log for steam-sbips which has been proposed and designed by Mr. Murdocb, of Portsmouth, who is doubtless well-known to most of our readers, as the esteemed chief Inspector of H. M. Steam Reserve.

Engine counters of various kinds have from time to time been patented but from the special features possessed by Mr. Murdoch's counter-log, it is admirably adapted for the purpose for which it is intended.

Mr. Murdoch has not patented this contrivance, he is, therefore, deserving of considerable credit, in placing at the command of the marine engineering world, this further result of his practical experience.

In the accompanying illustrations, Fig. 1 is a front elevation of face of dial for indicating the number of revolutions made by the engines according to time and their direction, whether ahead or astern.

Fig. 2 is a section of the same, showing the manner in which this is to be effected.

Upon the propeller or paddle shaft is fixed a bevel wheel, gearing into one of the same size on the vertical shaft E, causing it to revolve the same number of times as the engines, and without slip. Upon the vertical shaft E a cam is fitted working the counter A, also a pair of wheels turning the counter C, the direction being indicated by arrows, as shown on the face of dial.

A timepiece is inserted at D, which being compared with the counter A, will indicate the number of revolutions of engines per minute, and the speed of ship in knots, as sbown below.

A vessel being fitted with this arrangement, on proceeding to the measured mile, and the number of revolutions per knot and per minute being carefully registered, will have the following data for futnre guidance.

The number of revolutions per knot at full or half boiler power will form a constant number for that power, and the distance run by the ship can be ascertained by the counter, thus:—

FULL BOILER POWER.
Revolutions per minute = 60·91.
Speed in knots = 13 per hour.
Constant number of revolutions per knot = 281.

Revolutions.		Knots.
0 281,000,000	=	1,000,000
0 28,100,000	=	100,000
0 2,810,000	=	10,000
0 281,000	=	1,000
0 28,100	=	100
0 2,810	=	10
2 281 revs.	=	1 knot
8		
7		

HALF BOILER POWER.
Revolutions per minute = 48.
Speed in knots = 10·62 per hr.
Constant number of revolutions per knot = 271.

Revolutions.		Knots.
0 278,000,000	=	1,000,000
0 27,800,000	=	100,000
0 2,780,000	=	10,000
0 278,000	=	1,000
0 27,800	=	100
0 2,780	=	10
2 278 revs.	=	1 knot
7		
8		

The counter-log is fitted in a position so as to be readily accessible to the captain and engineer.

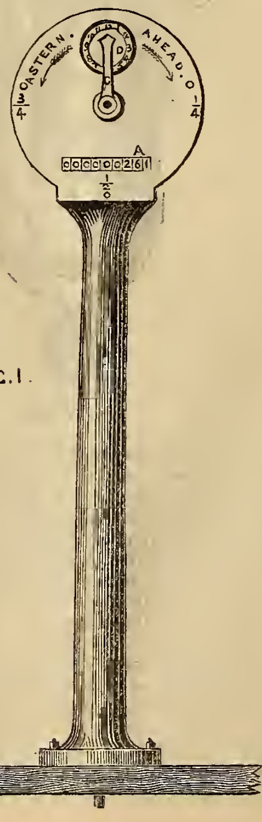


FIG. 1.

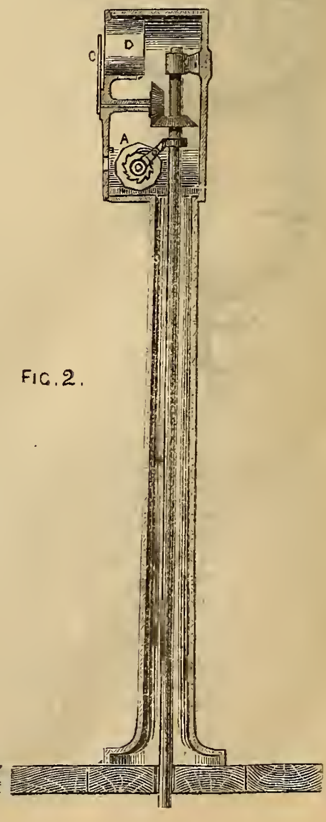


FIG. 2.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

The following is an abstract of the address delivered by Mr. G. Eedes Eachus, the President, on taking the chair for the first time after his election, October 10th, 1866.

Mr. Eachus, in taking the chair, offered his sincere thanks in acknowledgment of the distinction which has been conferred upon him, and stated that no efforts should be wanting on his part to follow to the utmost of his ability, the example which the late president had so faithfully given him. Mr. Eachus stated that though the institution, had been founded only seven years ago, its members now formed a numerous body, and there were at present many others anxious to avail themselves of the advantages which this society offers. Mr. Eachus announced that the following gentlemen,—Mr. Chas. Vignoles, F.R.S. &c.; Mr. G. Hemans, F.R.G.S., &c.; Col. Sir H. James, C.B., F.R.S., &c.; Mr. R. Sinclair, Capt. Symonds, R.N.—had signified their readiness to accept the invitation given them in accordance with the resolutions passed in June last, and to enrol their names as "Honorary Members of the Society." Their support and sympathy was hailed with satisfaction. It was in no spirit of rivalry with the older institutions, that members of this institution meet, but they sought, as young men entering upon their profession, by the interchange of ideas, and the influence of sympathetic thought, to lessen somewhat the difficulties which are necessarily incident to new work and untried ways; to accustom themselves, with distinctness and accuracy, to realise to their own minds, and to explain to others, the thoughts and plans suggesting themselves in the various branches of the profession, and, further, to learn to criticise and discuss with judgment, moderation, and candour, the opinions and schemes which those engaged in the same field of labour are continually offering for our consideration; and, so trained, they might hope some day to take their place among the more advanced members of the profession. It was sought by the members of this institution, voluntarily to gain that which the advocates of engineering diplomas consider would necessarily result from the adoption of such distinctive marks of the profession. "Whether that would in fact be secured by the introduction of diplomas, so as to add another advantage to those which they would undoubtedly possess, of raising our profession into a more recognised position, and a surer stand ground, among the other leading professions, I do not think it necessary here to enquire, but meanwhile we do well to embrace every opportunity to avail ourselves of all means which will tend to convert us from mere practical artists, to men of science and professional wisdom, and this, I repeat, is one of the principal objects which is aimed at, and I trust to a great extent gained, by our discussions and researches in this society." The president was happy to say that the members of the institution were kindly seconded in their efforts for instruction and improvement, by the persons engaged in the constructions of the great public works in the neighbourhood of the metropolis, which serve so well at once to rouse the ambition, and call out the powers of engineering minds. Every facility had been offered for the inspection of these works.

The President then stated he proposed to say a few words on the properties of materials used in engineering constructions, and their use in various structures, noticing briefly some of the improvements which have been recently made in the construction of machinery; then allude to the grand water-supply schemes which are at present before the public; the plans proposed for crossing the English Channel; the improvements made in military, telegraphic, and aeronautical engineering; and to conclude with a few observations on the works in progress or completed during the past year.

The properties of material used in engineering constructions are of two kinds—structural and chemical.

Of all materials used, stone is by far the most important; but the great increase in the value of it, which has of late taken place in consequence of the large engineering works in hand, has led men to look about to seek, if possible, some substitute for it. Granite, for instance, is now about 30 per cent. dearer than it was a short time since. Among such substitutes, Mr. Ransome's invention stands out prominently. He has succeeded in producing an artificial stone of a very superior kind, which is to be tried on a very large scale in New York. Cranston's Hotel, now in course of construction in that city, and to be completed next year, is being built with this material. The character of the materials used for cementing stones and bricks is of almost equal consequence with the stones and bricks themselves. In these cementing materials great improvements have been made, owing to the high requirements of several eminent engineers, and especially the engineers to the Board of Works.

The standard of weight and strength of cements has been so increased as to necessitate corresponding improvements in their manufacture; and certainly practical civil engineers will never specify materials which the manufacturer is unable to produce. Iron and steel must continue to increase in favour for engineering purposes—the latter, especially, giving proofs of such great tensile strain as to make the use of it an absolute necessity, whereas, for instance, in very large bridges it would not be possible to secure the span required if wrought and cast iron, which have less strength, and consequently greater weight, could alone be used upon the work.

The President stated it was with pleasure that he had heard of the formation of a committee, consisting of some of the leading engineers, to give to steel a more perfect trial than it has yet received. At present iron and steel are but little used in the construction of breakwaters and other sea defence, though they enter largely in the construction of jetties, piers, and other shipping conveniences; but it seems well that they should be employed much more freely in all such constructions, as by the use of them not only would the expense be much diminished, but it would then be possible to imitate similar works in the Mediterranean, where the sea-walls are built on arches, to allow the free passage and consequent scouring of the deep water. It is necessary, further, that we should acqaint ourselves with the chemical properties of our materials. The chemical properties of stones are important, as they bear upon the number of years they may be expected to last, and on the expedients we can resort to in order to prevent their decay. The chemical action of the air and its constituents has an exceedingly injurious effect on some stones, and, to obviate this, various chemical processes have been proposed. Mr. Ransome's process seems to be the most effectual, and consists in the application of a soluble silicate of lime, followed by a solution of chloride of calcium. On the Houses of Parliament, where so much is feared from the unceasing decay of the stone, this and other methods have been tried, but not on as large a scale as they deserve. Colonel Szerelmey's zopissa cement seems to have many good qualities; but whether it would act as a preservative to stone, the President thought was not yet sufficiently evident to warrant its use for that purpose; but, as a cementing material for uniting any two solid bodies, it appeared to him unrivalled.

A better knowledge of chemistry has also been the means of effecting many great improvements in the manufacture of iron. M. Gaudin discovered two ways of producing a very hard iron, the one by adding to cast iron infusion, boron, and the other by adding phosphate of iron and peroxide of manganese; the metal thus produced he recommended as a material for bells as being very sonorous.

Geology also lends her aid in no small degree to the civil engineer, and papers on the relations of some of these collateral branches to the science of engineering would be welcomed by this society.

The qualities of steel would likewise offer an excellent subject for examination and discussion and he would recommend it to the notice of the members as of prominent interest and importance.

The improvements in machinery are so numerous that he would only remind one of the members, Mr. Müller, who has promised a continuation of his paper on railways over the Alps that it would be gratifying to the society if he would include therein descriptions of the improvements in the boring machine used for the tunnelling under the Alps, and also of Mr. Fell's locomotive for ascending the steep inclines of the same mountains, reference to both of which contrivances has already been made in the pages of THE ARTIZAN.

The President in proceeding to make a few remarks on the different schemes for supplying London with pure water and in larger quantities than the present companies are able to do, drew attention first to the scheme of Mr. Bateman, which he looked upon as one of the best. Mr. Bateman advocated the supply of water to London from the sources of the Severn.

After shewing the rate of increase in the population of the Metropolis and the still greater growth of the suburbs, Mr. Bateman very justly concludes that a greater quantity of water will be required for their supply, and further from the increase in the amount of impurities contained in the water that there be also necessitated a purer and softer quality. It has been suggested that the present water is good enough for washing purposes, and that water of the purest kind should be supplied only for drinking purposes, but in truth for washing also the softer water would be required, as the softer the water the less the amount of soap used, and consequently so much less the expense of cleanliness. Indeed Mr. Bateman estimates this saving at £400,000 per annum. It is probable that the Thames water, in the course of a few years, will be much purer than at present, and a bill for Thames purification was passed in this last session, but with all our efforts in that direction some measures of an entirely new character will have to be adopted. Mr. Bateman, arguing from the quantity of water at present used in the Metropolis, and taking into consideration the increase according to past years, is of opinion that no scheme deserves attention unless by gravitation it is able to supply the Metropolitan district with 200 million gallons per day. The nearest district for such supply is to be found in the upper basin of the tributaries of the River Severn.

The fall of rain there may be safely estimated at 70 or 80 inches per annum, but Mr. Bateman's calculations are based on about one-half or 36 inches per annum.

There are no metalliferous veins to contaminate the water in these districts, which have a total area of some 120,000 acres, and the discharge pipes of the lowest reservoirs would be placed 450 feet above Trinity high water mark. From the two districts which Mr. Bateman selects, he would carry separate aqueducts to Martenmere, each capable of conducting 130 million gallons per day. From Martenmere the water would be conducted by a common aqueduct capable of conveying 220 million gallons daily to the high land near Stanmore, where reservoirs would be placed for supplying the Metropolitan districts at high pressure and on the constant supply system. It is probable that the water derived from the above sources will be about 1° of hardness with about 1·25 grains of organic impurity.

The President then gave a *resumé* of Mr. Bateman's estimates of the cost of the undertaking, the probable receipts, &c.

The next scheme of water supply alluded to was that of Messrs. Hemans and Hassard, which, like the one proposed by Mr. Dale, of the Hull Corporation Waterworks, would look for the water supply from the Cumberland Lakes. Messrs. Hemans and Hassard, however, propose to supply the Metropolis and towns in the direct route to London, while Mr. Dale proposed to convey the water to the populous districts of Yorkshire and Lancashire. The lakes from which the water would be taken lie at a distance of 240 miles from London, and Messrs. Hemans and Hassard would provide for a daily supply of 200 million gallons for the metropolitan districs, with a further 50 millions for sale to districts traversed by the aqueduct.

The several works embraced in Messrs. Hemans and Hassard's scheme were then very clearly described by the President, who next proceeded to refer to the scheme of Mr. Fulton, which, it is stated, is to be brought forward next Session by the existing water companies, who, doubtless, are reluctant to relinquish their large profits, and finding Mr. Fulton's estimate considerably below those previously mentioned, seem inclined to support it.

Mr. Fulton's plan resembles very much Mr. Bateman's, but the service is not sought for so far as he proposes to take the supply from a little above Tewkes-

bury, to do which he must divert the sewage of all the towns above that point. And if this is impracticable, he would propose to take the water from the sources of the river Wye. In the latter case the estimate would be about five millions and a half, in the former only three millions.

There is another suggestion from Mr. Gower, with an estimate of £4,328,500 but this it is considered is not likely to be adopted as being only a partial remedy. This gentleman would not supply soft water for washing but only for drinking purposes. But as we have said, a great saving would be effected by the use of soft water for washing purposes, which would be set off against the increase in the originel outlay, and we may feel certain that no scheme for the supply of the metropolis will be adopted, which does not supply soft water, and and soft water only. The president mentioned *en passent* that Messrs. Rawlinson and Duncan have both brought forward plans for the supply of water to Liverpool from Bala Lake.

The schemes for crossing the Channel are even bolder than those for the water supply of London. This communication, however, is less important than the other great measures which are urgently called for, as essential to the cleanlines and well-being of the inhabitants of this vast metropolis; it is, consequently less likely of a speedy accomplishment, the president, therefore, alluded but briefly to the several plans suggested.

Military engineering now becomes a part of the civil engineer's education, and the successful progress in the manufacture of large artillery makes it a matter alike interesting and important, interesting on account of the great experience, it gives in the manufacture and manipulation of the largest masses of metal, and of the utmost importance, not only because artillery forms the vital strength of our national defences, but also because we are sadly forced to admit that notwithstanding all her expenditure, England is now in this respect behind two if not three other European nations, and these the nations from whom she would always have most to fear.

The President after remarking that the Americans, without doubt, are far ahead of us in the size of their naval artillery, and alluding to the Rodman gun, proceeded thus:—

The French are also unanimously in favour of heavy guns for their fleet, the ironclad portion of which we must in sorrow allow to be cased with much thicker metal than our own ironclads. They have eighteen vessels with a 6in. coating, and seven with 8in. coating, against three vessels of ours with 6in. and one with an 8in. coating. The French seem also to have adopted the plan of casting their large guns, and have apparently succeeded in making guns capable of throwing 150lb. or 300lb. shot.

It is, I believe, the fact that the largest cast gun at present employed in the English navy is the Somerset 100-pounder; the Woolwich authorities seeming to be bent upon making larger guns according to some one or more of the built-up processes. The Armstrong has been for some years the favourite at Woolwich; but, owing to its numerous failures, this seems about to be finally abandoned for some other method, and it is to be hoped, for the sake of England's purse, credit, and power, that better success will attend the efforts of the present Government than we have recently seen achieved in this department, as they succeed to their work invigorated by a long term of repose. Perhaps the principal methods of construction now before the English public, and which may be briefly mentioned, are, in addition to the well-known Armstrong, the Blakely, the Fraser, the Mackay, the Whitworth, the Pallisser, the Parson's, the New Woolwich, the Ericcson, the Longridge, the Ames, the Krupp, and the non-recoil gun.

The Blakely system, which includes the Armstrong, Fraser, and new Woolwich, is, as well known, founded on the principle of strengthening guns or tubes by means of hoops or rings shrunk on, so as to give an external tension and an internal compression to the material. The Fraser, Armstrong, and Woolwich guns differ from the Blakely merely in the construction of the hoops, or the mode of putting them on, so as to include the breech.

The Palliser and Parson's guns are constructed on a different principle and have for their chief object the making use of the existing stock of old guns. In these systems a steel tube is inserted into the bore, and it need not be said that to do this requires the most careful workmanship or very uncertain results will be obtained. The Mackay gun like the Whitworth is not so much a novel construction of gun as a new method of rifling, but the principles of the two systems are exactly opposite.

The Whitworth aiming at tight close fitting shot would require to be made according to one of the above mentioned methods if made of a larger calibre, the Mackay having a very great amount of windage allows English gunpowder to act similarly to the slow burning powder used by the Chinese and probably by the Americans, for it is scarcely likely that the Rodman cast guns would stand a full charge of English powder.

The Mackay gun principle then is suitable for guns throwing heavy shot, and such guns on account of the rotation given to the shot would excel the Rodman or Somerset smooth bores not only in point of accuracy, but also in durability if strengthened on the Blakely system. The Ames' gun is purely a wrought iron gun made by welding together in succession rings or cross sections of the gun and possesses no advantage of initial tension, but merely of material; as might be expected it yields beyond the limit of elasticy so as to become permanently enlarged.

The plan which has been proposed of inserting a steel tube into the bore would probably prolong the life of such a gun, but it would thus become a most costly article and scarcely less difficult to make than the cast steel guns of Krupp.

There are two other methods of strengthening a tube to form a gun. One is the Ericsson method, which consists in forcing on to the conical tube discs of iron or steel; but here, again, as in the Blakely, there must be most careful workmanship, otherwise no satisfactory results can be anticipated. The other plan is an old one as regards the time of being patented, and has not yet received the attention it deserves. I allude to the wire system of Mr. Longridge. This, in fact, is the same as the Blakely system, carried almost to perfection as regards the number of rings or hoops, but without its disadvantage of requiring great accuracy of work. In fact, in the wire system, a gun can be made of almost unlimited size or strength, and that, moreover, at very much less cost than on any of the other systems. The limit to the size is not the difficulty of manufacture, but the mere question of facility of use. In this system, where the wire is wound with a calculated tension on a rough light casting of steel or iron, a gun can be made with all the advantages of steel for the interior, and of steel wire, the very strongest material known, for the outer portion, and the gun is made in the easiest manner by winding on the wire. This is the cheapest form of gun: the cost, for instance, of a 600-pounder on the Woolwich system is £4,000, while the same-sized and more effective gun constructed on the Longridge system would cost about £800 or £1,000. If this system were applied to the non-recoil gun, I think we should have a more effective and cheaper gun than any at present in use. The question of breech-loading small arms is also one of great interest to the engineer, as it is a question of the best mechanical means to accomplish a definite end; and here, again, the Americans have gone ahead of us, as there is little doubt that, as effective weapons, the Spencer, Henry, and other repeaters must be superior to a simple breech-loader, like the Suider. To attempt any enumeration or description of the various kinds would far surpass the limits of this address, inasmuch as, according to report, in France alone there are being tried 160 different schemes. And I will conclude this portion of my address by recommending the study of this problem to the members of this Society, as being one in which young and old may compete on almost equal terms; while the production of superior arms would in time of war prove an infinite advantage to the English nation.

[We hope to be able to give the continuation of Mr. Eachus's address in our next.—Ed. Artizan.]

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

On Saturday, the 6th ult., an ordinary monthly meeting of this Association was held at its rooms, Doctors' Commons, City. The chair was occupied by Mr. Joseph Newton, and, after the routine business had been disposed of, Mr. Briggs proceeded to read a second paper on "The Concussion of Water in Pumps and Pipes." The subject, however, had on previous occasions been so fully ventilated and discussed by the Associated Foremen that it was scarcely possible for Mr. Briggs to shed much new light upon it, and he certainly did not succeed in doing so. Messrs. Stabler, Irvine, Keyte, Jensen, and others nevertheless entered lengthily afterwards into many practical points referred to in the paper, and thus contributed towards making the evening's arrangements more interesting and instructive than they otherwise would have been. On the conclusion of the discussion, a vote of thanks was awarded to Mr. Briggs, and then Mr. David Walker (Secretary) read a short, but suggestive paper on the best means for increasing the usefulness of the institution, especially in so far as related to obtaining situations for unemployed members. Mr. Walker considered that too much apathy was exhibited in this direction, and that thus one of the main features of the institution had been lost sight of. It was the bounden duty of one and all the members who were in employment to keep a watchful eye on behalf of those who were not, and to report to the secretary without delay any knowledge they might possess of vacancies or probable vacancies in engineering establishments. Fortunately, he said, there were very few of their body at present unemployed; but it was still necessary to devise and complete arrangements for obviating the evils of "a rainy day." Mr. Walker's remarks appeared to create much interest, and it is to be hoped they will produce a beneficial effect.

The chairman next read a communication from William Fairbairn, Esq., C.E., in which that gentleman highly eulogised the society, and expressed an opinion that "the Association of Foremen Engineers was one of those institutions which tend to the improvement and advancement of practical science." He wished it, therefore, every success. Mr. Fairbairn's letter was received with great favour. Mr. Newton further read some correspondence which had passed between Mr. Walthew, secretary of the Manchester Society of Foremen, Mr. Oubridge, one of its members, and himself. The purport of this was the expression of a desire on all sides for closer communion between the London and the Manchester Associations. It was also incidentally stated by the chairman that similar societies were either in active and useful existenes, or in process of formation, in Leeds, Glasgow, Birkenhead, and Sunderland. In all these cases the rules had been framed on the model of those of the London Association of Foremen, and they were, therefore, in no way inimical to the interests of engineering employers, but, on the contrary, highly favourable to them. Much applause greeted these remarks, and finally the chairman announced that he should endeavour, at the November sitting, to read a paper on "Ansell's Fire-damp Indicator," when the inventor himself would be present with examples of each form of the ingenious apparatus for the purposes of illustration and experiment. The meeting was then adjourned to the 3rd inst.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON THE CONNECTION OF PLATES OF IRON AND STEEL IN SHIPBUILDING, ESPECIALLY SUCH AS ARE SUBJECT TO SUDDEN TENSIBLE STRAINS.

By MR. NATHANIEL BARNABY, Assistant Constructor of H.M. Navy, Member of Council of Institution of Naval Architects.

Much yet remains to be done to make iron shipbuilding a perfect art, and there is perhaps no one step remaining to be taken in the path of improvement more important than that of substituting a simple and efficient means of joining plates by welding, should it ever be discovered, for the present system of rivetting.

The loss of strength caused by the present system is considerable in iron, but appears to be still more serious in steel. It forms, in fact, the great bar to the introduction of this most promising material into ships of war.

I may give as an illustration of this, one or two of the many experiments which have been made by the Admiralty at Chatham Yard, on Bessemer steel of the best quality.

A piece of steel 4ft. long, and 12in. broad, was cut from a half-inch plate, of which the proof strength was 35 tons per square inch. This piece was reduced to 5in, in width at the middle, was supported at the ends by square plates rivetted to it, as shown in Fig. 1, and was carefully centred.

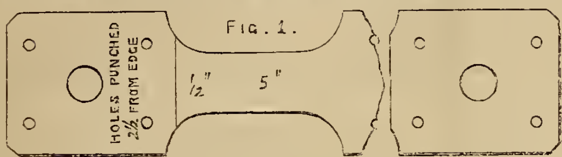


FIG. 1.

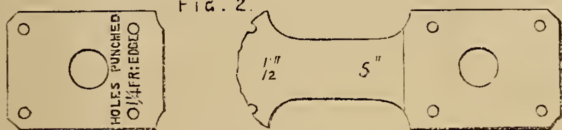


FIG. 2.

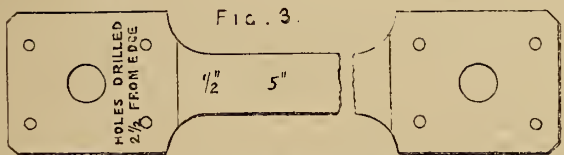


FIG. 3.

The plate should have broken at $82\frac{1}{2}$ tons, and through the narrow part. It actually broke at $95\frac{1}{4}$ tons, and then, strange to say, broke through the wide part of the plate, tearing away through the rivet holes. Thus while the material in the middle of the plate withstood a strain of 38 tons per square inch, it actually broke through the holes at 16·38 tons per square inch, or less than one-half the strain.

In a precisely similar plate, differing from the other only in the fact that the rivets connecting the end pieces were $1\frac{1}{4}$in. from the edge instead of $2\frac{1}{8}$in., the plate broke in a similar manner (Fig 2), at 73 tons, which is only 15 tons per square inch of the section of steel broken. The holes in both these cases had been punched, and in order to ascertain whether these curious results were due to the injury supposed to result from punching, an exactly similar arrangement of plates was again tried, in which the holes were, as in the first, $2\frac{1}{8}$in. from the edge, but were drilled instead of being punched. The plate then broke through the narrow part (Fig. 3), at 106·75 tons, or 47·53 tons per square inch of the steel broken. I do not propose to draw here any inferences from the experiments detailed, or from the series of which they form part, further than this, that all which I propose to say concerning the necessity of bestowing greater attention on the comparative strength of different modes of connecting plates intended to give tensile strength, is even more applicable to steel than to iron.

$23'' \times \frac{3}{4}'' \times 20'' = 345.$

$21'' \times \frac{3}{4}'' \times 16'' = 252$
3 rivets twice = 107
359

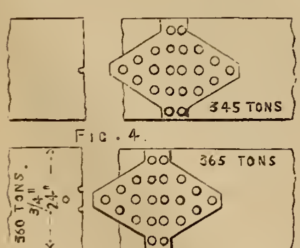


FIG. 4.

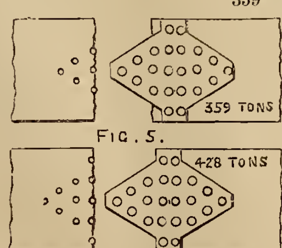


FIG. 5.

$22'' \times \frac{3}{4}'' \times 20 = 330$
1 rivet shear twice = 35
365

$19'' \times \frac{3}{4}'' \times 15\frac{1}{4}'' = 214$
6 rivets twice = 214
428

Admitting then, that for the present at least, we must be content to connect iron plates by rivets placed in holes punched or drilled out of the material, and therefore by the sacrifice of a considerable portion of the strength of the plate, it is manifestly the duty of the engineer and shipbuilder to study to make this connection with as little sacrifice of strength as possible.

In every such connection the tensile strength of the plates across the outer line of holes, of the butt strap or straps across the inner line of holes, and the resistance of the rivets to shearing should be all equal. Two plates may be connected, for example, by butt straps, as shown in the Figures 4, 5, 6, 7, and 8, so as to reduce the strength of the plate by one hole only.

11 rivets shear twice = 392.

$19'' \times \frac{3}{4}'' \times 15'' = 214$
$9'' \times \frac{11}{16}'' \times 2 \times 15 = 185$
399

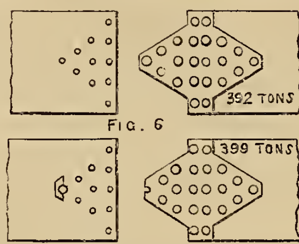


FIG. 6.

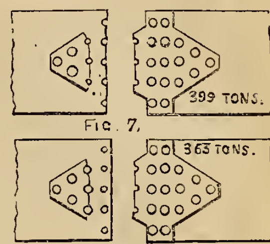


FIG. 7.

$2'' \times \frac{11}{16}'' \times 2'' \times 15'' = 41$
10 rivets shear twice = 358
399

$9'' \times \frac{11}{16}'' \times 2'' \times 15'' = 185$
5 rivets shear twice = 178
363

$6'' \times \frac{11}{16}'' \times 2'' \times 15'' = 124$
8 rivets shear twice = 285
409

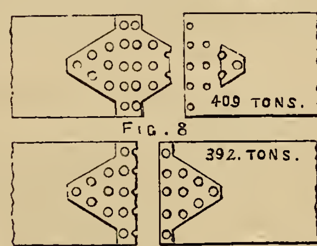
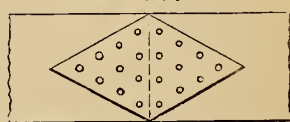


FIG. 8.

FIG. 9.



$19'' \times \frac{11}{16}'' \times 2'' \times 15'' = 392$

The strength of the several parts has in this case been estimated on the assumption, verified by careful experiment at Chatham, that the shearing value of a $\frac{3}{4}$ Bowling rivet, including friction, and taken either singly or in conjunction with others, is 10 tons, and that of rivets of other diameters is in proportion to the squares of the diameters; also, that the tensile value of the iron between the holes is reduced in proportion to the number of the perforations, and that this reduction is about 25 per cent. when the holes are punched three or four diameters apart.

This description of butt strap it of no value in shipbuilding, because the stringer and tie plates, to which it might otherwise be applied, have to be perforated between the butts by rows of holes to connect them with the beams.

In such plates, in order to economize material, it is therefore desirable to reduce the amount of fastening at the beams as much as possible. I do not think it necessary to punch away for this purpose more than $\frac{1}{8}$ of the iron; the remaining strength of the iron would then probably be $\frac{7}{8} \times \frac{7}{8} = \frac{7}{9}$ths of the whole, so that the straps connecting them should also give $\frac{7}{9}$ths of the whole of the plates. Any greater strength at the butts would, of course, be thrown away.

If the butt strap has to be caulked, this proportion of strength cannot be retained, as the rivet holes must then be placed nearer together.

Let us take, for example, the connection, by means of a butt strap, of two plates, $\frac{3}{4}$in. thick and 12in. wide, in which the rivets are 1in. diameter, and are spaced three diameters apart.

Then we punch out $\frac{1}{3}$ of the iron, reduce the strength of the remaining iron about one-fourth, and have left only $\frac{2}{3} \times \frac{3}{4} = \frac{1}{2}$.

The tensile strength of the plate at 20 tons to the inch is 180 tons, and the tensile strength through the holes about 90 tons.

If the connection is made by means of a single strap, the value of the rivets will be about 71 tons; and if by a double strap, 142 tons. No appreciable advantage could be obtained from a second row of rivets in this case, unless the spacing along the edge could be increased.

If the rivets are no nearer together than is necessary for caulking, a second or third row could give no advantage, except in enabling us to reduce the thickness of the butt straps to less than the thickness of the plate, by reducing the number of rivets in the inner row where the butt straps are bliged to break.

None of these considerations are new, but they have been so much neglected that those who are familiar with them will, I hope, justify me in thus restating

them. But there are certain other considerations equally important, which have, I think, altogether escaped the uotice of shipbuilders.

Let us suppose that we have a stringer or tie plate, the strength of which is, at the beams, and at the butts, $\frac{4}{5}$ of the full streugth of the plates, and that we have no means of increasing the strength at these poiuts. Have we any means by which we can, without altering the strength at these points, increase the tensile power of the plate? I think the answer would generally be, we have not —the strength of the tie will be measured hy the strength at the weakest place, and this strength is fixed.

Now what I want to show is that this is not the case, and that we have overlooked an important clement of strength, which is conducive to economy of material.

Take the case of a stringcr or tie plate, crossing a number of beams, say 3ft. 6in. apart, at each of which the strength is reduced to $\frac{4}{5}$ths of the full strength of the plate.

If this plate is brought under the action of a steady strain it is a matter of indifference practically how many such points of weakness there may he, and how much stronger the material may be lying between the weak points. But when strains are suddenly applied, we have to consider not only tbe number of tons required to break the weakest section, hut the amount which it would stretch before breaking. It is, in fact, thc work done in producing rupture, viz.: the force applied, multiplied by the distance through which it acts, which is the true measure of the resistance to rupture.

Under these circnmstances no elongation will take place in the strong parts of the plate lying between the beams; it will all be thrown on the weak points; and if any one of these be weaker in any sensible degrce than the rest it will be confined to that point.

This being the case a large incrcase of power may be obtained by reducing the strength of the plate between the weak points to the strength at these points, or even to less than this, provided we get long spaces of uniform streugth to give elongation.

To illustrate this I beg leave to refer you to some experiments made at Chatham with armour bolts, with reference to a proposal of Captain Palliser's.

The proposal was to apply to armour bolts, having screws cut on them, the well-known principle that the bolts wonld be streugthened at the screw thread, and become less liable to break by a sudden jar, if the holt, or a portion of it beyond the thread, were reduced in section to the same area as the iron left uncut at the thread.

The experiments referred to, made under my own careful observation, showed—

1. That iron bolts of good quality and of uuiform diameter, subjected to a steadily increasing strain, clongate before breaking about one-fifth of their original length.

2. If the diameter is not uniform, but is decreased through a portion of the length, theu the reduced part elongates ahont one-fifth of its length before breaking, and the larger portion scarcely stretches at all.

3. If this reduced part is very short, as in the thread of a screw, the strain required to break the bolt is the same per square iuch of the unstretched or original section as in the previous cases, bnt therc is scarcely any clongation before rupture.

4. If the whole length of the bolt is made to the rednced diameter of the screw thread, so that the thread projects from the bolt, the breaking strain (gradually applied) is the same as before, hut as the bolt will stretch one-fifth of its length before breakiug, it becomes thereby less liable to rupture by a sudden blow because, as already stated, the work done in producing rupture is in proportion to the weigh or strain applied, multiplied hy the elongation or the distance through which it is applied.

The details of one portion of these experimeuts were as follows:—

Four bolts were taken, all made of best-selected scrap irou, for the purpose of the experiment, and all of the same diameter, viz.:—$2\frac{1}{4}$in.; screw threads were cut in the ends of these, and nuts fitted. The other ends were formed with heads, leaving a length of 21in. between the heads and the nuts. The four bolts heing thus as nearly alike in every respect as they could be made, two of them were reducad down on the anvil for a length $4\frac{1}{2}$in. in the middle of their length, to a diameter of $1\frac{7}{8}$in., which was the same as that of the iron remaining within the screw threads, the other two bolts retained the full diameter throughout. They were brokeu in the hydraube press, with the following results:—

		Breaking Strain in Tons.	Sq. In. in Sec. broken.	Tons. per Sq. In of this Sec.	Elongation.			Where broken.
					In 5 in.	In 15in.	In 21in.	
Bolts not reduced,	No. 1,	63	2·76	22·8	Nil.	$\frac{1}{4}$	$\frac{1}{4}$	At thread
	No. 2,	69	2·76	25·0	Nil.	$\frac{5}{16}$	$\frac{1}{2}$ bare	Ditto
Bolts re-reduced,	No. 1,	64	1·67	38·33	$\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	In reduced part.
	No. 2,	65·5	2·07	31·58	$\frac{7}{8}$	1	$1\frac{1}{8}$	In rednced part. but at tbe shoulder where there was a slight defect

The fact that the strains of greatest magnitude in a ship are sndden in tbeir nature makes tbe principle nnder consideration one of no slight importance, because we see that by its application we are able to increase the time during which a given force must be applied in order to produce rupture.

As the material is disposed at present in iron decks, and stringer and tie plates, the plates are perforatcd in the liues of the heams, not only by the holes required for the rivcts to attach the plating to the bcams, but by the deck bolts which secure the wooden deck lying ou the iron plating.

The loss from the irou punched out, and the weakening of that which remains, amounts, on the whole, to from 30 to 40 per cent. of the original strength of the platcs. These lines of weakness occur at intervals of about 3ft. 6in., and between them the plate has its full strength, except where a butt occurs.

The consequencc of this is that when the dcck is put in tension, the stretching is confined to thcse weak places, and the amount of work which the whole combination is capahle of doing before rupture is extremely limited. In order to remedy this state of things, I propose to remove all the woodeu deck fasteuing from these weak places, and put it on either side of the heam. The number of rivets for attaching thc plating I also propose to reduce. By this meaus a strength of plating is obtained across thc lines of rivetting of about three-fourths of the full strength of the plates. The next thing to he done is to reducc the strength of the plating between the beams to the same amount. This might be done by cutting holes in the plates; but instead of this I propose to omit the butt straps, and to arrange the plates so that in each of these spaces there shall be a continuous series of butts and plates, in the proportion of one butt for every three plates. In addition to this reduction of material, I propose to leave intervals hetweeu the butts of about one-third the distance betwecn the beams, so as to get long spaces of uniform strength between the beams.

The length of the intervals between the bntts will be determined by the number of rivets which can be placed in the edge of the butted plate between the beam and the butt, as there must be sufficient to break the plate across the beam. A short piece of edge strip ou the under side douhles the shearing value of the rivets. and allows about one-third of the distance bctwcen the beams to be omitted.

The advantages of one system over the other are, I think, the following:—

1. In tbe ordinary system one-fifth or oue-sixth of the irou is punched away: by that proposed only one-ninth or one-tcnth is punched out. There is from this cause a gain in direct tensile strength, to which must be added an increase of strcngth in the iron between the holes. These are together equal to about 12 per cent.

2. The strength of an iron deck under *compression* is limited, not by the area of section, but hy its resistance to buckling between the beams. According to the ordinary mode this is very small, since it is quite free to bend downwards hetween the beams. But by spacing the deck fastening, as showu, at intervals of about 2ft. iustead of 3ft. 6in,, tbe tendency to buckling would be reduced The wooden deck would thus, both by its owu direct resistance to compression, and by the support it gives to the plates, play a most useful part in compression, although it is powerless as against extension when in connection with iron. I therefore conclude that no loss of compressive strength is incurred by the holes in the plates.

3. All the holes for receiving the deck fasteuing may be punched, whereas if the fastening is in the heam flanges, the holes for them must be drilled either in the plates or in the beams.

4. The expense of cuttiug, fitting, punching, and rivetting butt straps is avoided. Where the material employed is steel, the gain is more considerable, as all the holes in the butts of the plates and in the straps, have to be drilled to prevent the injury done by punching.

5. The weight of material omitted at the butts amouuts to one-seventh of the whole material employed.

6. There is a gain in strength against injury and rupture by the action of sudden forces. the amount of which is not perceptible of calculation. but which, being in proportion to the extent of the spaces of uniform streugth which have been introduced, is, I think, very considerable.

The novelty of this proposal may be said to consist in so arranging the iron or other metal plates forming the flanges of girders, bridges, and other structures, or employed in decks, partial decks, stringers, or ties in a ship or vessel, as to make the tensile strength of the unperforated plates, intervening between adjaceut butts, eqnal or nearly equal to the strength of the said intcrvening plates taken together with that of one of the hutted plates where they are pcrforated, *i.e.*, across the row of holes made for the purpose of attaching the plates to the beams, angle irons, stiffeners, or other iron framiug, and by this means rendering thc use of butt straps in such combinations unnecessary. In other words, a section through the plates between the beams or stiffeuers is made to have, without butt straps, about the same tensile strength as a section through the fastening at the beams or stiffeuers, for the purpose of forming spaces of uniform tensile strengtb not greater than that of the weakest place in the combination. In these intervals elongation will take place (to an extent depending on their length) before the materials can be ruptnred, so that an increased amount of work will requirc to be done by the operation of a given strain in producing rupture; also, in increasing the resistauce to ruptnre under sudden strains in single plates, by reducing the tensile strength throughout certain intervals between the beams, augle irous, or stiffeners, and approximating to that at the heams, angle irons, or stiffeners, by cuttiug out portions of the plate.

I am aware that iron decks are not used in merchant vessels, although they are in all iron war ships huilt for the Admiralty; and I consider it to be false cconomy to substitnte, for such decks or partial decks, striugers on tbe ends of the beams, tie plates near their middle, and diagonal braces between them, as I think it clear that from the round up of the heams, and other causes, a considerable portion of this material is uuable to succour the rest when the top of the ship is put in tensiou or compression.

Tbe strength of wrought iron in extension and in compression is about the same; yet the bottom of the ship is usually made enormously stronger than the top.

Somc iron ships, indeed, have no proper top, or only a wooden one. Much of

the strength of the bottom, which might otherwise be made available in giving strength to the ship, considered as a floating girder, is thus wasted.

I indulge the hope that the economical considerations pointed out may be not only useful in lightening and strengthening ships designed for war, but in inducing private shipbuilders to introduce partial iron decks, so formed, into ships designed for commerce. I may, perhaps, be allowed to add, in conclusion, that these proposals do not form the subject of any patent.

In the discussion which took place after the reading of this paper,

Mr. George Russell pointed to a diagram on the wall (fig. 9), illustrating a form of butt strap exactly similar to that proposed by Mr. Barnaby, and said that he had sent it two weeks ago with a view of introducing it at the previous meeting. It was about four or five years ago since he made it. Now, the only thing that Mr. Barnaby had not referred to was any difference in the thickness of the plate and the butt strap. It was evident that the strap would be as weak as the plate if it were not made thicker than the plate. The butt strap must be of such a thickness that the sectional area of it, at the line of rivets nearest the joining, will be equal to the sectional area of the plate less one rivet. If the strength of the various points of the plate were examined, it would be found that at the first hole it was weakened by the diameter of one rivet, and the second was weaker by two diameters. But before the plate could give way at the second row of two rivets, the rivet furthest from the joining must be shorn through, so that the strength of the plate at the first and second rows is equal; at the third row the strength is equal to the solid plate; at the fourth row it is stronger than the plate, thus increasing in strength as it approaches the joining. He did not know whether that rivet joint was new or not; but he thought it could be applied to a good many purposes. The form of strap that Mr. Barnaby referred to would cause a great waste of material; whereas if it were of a simple diamond shape, as shown on this diagram, it could be cut out of parallel plates without waste.

The President said that in a stringer the strength, or rather, as Mr. Barnaby puts it, the elasticity should be the same all over its length, so that a ship taking a bank would not be damaged in the middle. Perhaps by leaving out one or two butt straps this was attained, so that the strength or elasticity of the section of the deck through the space where the butt strap was omitted might be the same as it was where there were a great number of rivet holes. Mr. Barnaby's aim was to make the iron equal in strength and elasticity in all parts.

Mr. Boolds said one was at a loss to see what advantage there was gained in leaving out the butt straps. He knew that they gave a certain amount of strength to plates in combination in a ship; and, if there were four or five, or a dozen, butts across a ship's deck having no connection as these were, he did not see what advantage there could be in leaving out the butt straps. For instance, in a ship spaced like the diagram on the wall, there were a dozen butts. These plates were 18in. broad, and there were 18ft. across that ship not connected; and with respect to the number of rivets in a butt, he had attended a great many experiments made in London, and it was found that after two rows of rivets the joint did not gain much strength, but that it broke off after the second row—that an advantage was found in chain rivetting.

Mr. J. Howden remarked that Mr. Barnaby's method had great elasticity. He thought the great elasticity of the deck would be a disadvantage to the sheer-strake. While he thought that great elasticity of the deck would increase its strength, it would throw the strain on the sides of the ship, where it could ill bear it.

DEMONSTRATION OF A RULE FOR CALCULATING THE DISPLACEMENT OF SHIPS WITH TROCHOID WATER LINES AND CERTAIN FORMS OF MIDSHIP SECTIONS.

By Mr. JAS. R. NAPIER.

The following communication is a demonstration of a rule used by the the author in designing some vessels which had trochoid water lines. Whether the displacement calculated by it be exactly, or only approximately correct, according as the lines are exactly or approximately trochoids, the rule saves much of the preliminary work of measurement and calculation.

The area of a trochoid is known to be equal to its length multiplied by half its breadth, plus the area of the circle whose radius is half the trochoid's breadth, and the area of a trochoid water line is the double of this. The general expression for the displacement of a ship with such water lines will therefore be:—

$$D = 2 \int y \frac{L}{2} dx + 2 \int \frac{\pi}{2} y^2 dx,$$

where y is the greatest breadth of the trochoid,
L the length of the trochoid, and
dx an infinitely small portion of the depth of the vessel,

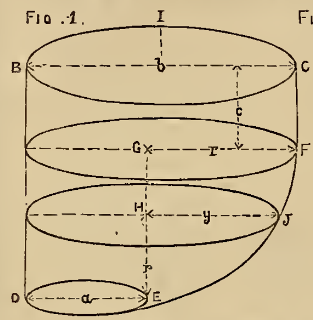
$$2 \int y \frac{L}{2} dx = \frac{L}{2} \int 2 y \, dx = \frac{L}{2} \times \text{area of midship section.}$$

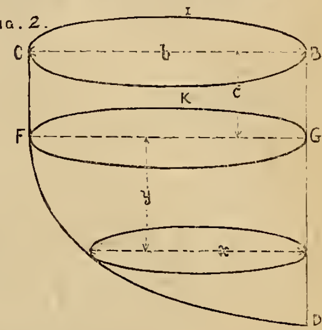
$$\therefore D = \frac{L}{2} \times \text{area of midship section, } + 2 \int \frac{\pi}{4} y^2 dx.$$

The solution then lies in finding the value of $\int \frac{\pi}{4} y^2 dx$, which represents the volume of a solid, which may be supposed to be generated by a circle moving parallel to itself, and whose diameter is, at each point of its motion, equal to half the breadth of the vessel at that water line. When the midship section is of certain known curves or forms, the integral may be easily found Or, as this solid must be one-fourth of the volume of the solid that would be generated by the revolution of the midship section about its axis of symmetry (the centre line), its volume for a midship section of *any* form may, with a little labour, be found by Pappus's or Guildin's method.

The certain forms of section alluded to in the title, are those with flat bottoms, and circular bilges, and parabolic sections. Other sections will be included by those whose knowledge of mathematics is more extensive.

FOR SECTIONS WITH FLAT BOTTOMS AND CIRCULAR BILGES.





(FIG. 1.)

Let BCD be half the midship section,
GE = GF = r radius of bilge,
DE = a half of flat bottom,
BC = b half the breadth of vessel,
BD = d the draft of water,
CF = c and parallel to BD,
GH = x,
HJ = y.

Then the volume $\mho$ of solid BICJED = vols. of BICF + GFJED

$$= \frac{\pi}{4} b^2 c + \frac{\pi}{4} \int_0 (a + y)^2 dx;$$

but as $y^2 = r^2 - x^2$ and consequently $y = (r^2 - x^2)^{\frac{1}{2}}$

$$\mho = \frac{\pi}{4} b^2 c + \frac{\pi}{4} \int_0^r \left\{ a^2 + r^2 - x^2 + 2a (r^2 - x^2)^{\frac{1}{2}} \right\} dx$$

$$= \frac{\pi}{4} b^2 c + \frac{\pi}{4} \left| \left\{ a^2 x + r^2 x - \frac{x^3}{3} + x (r^2 - x^2)^{\frac{1}{2}} + a r^2 \sin.^{-1} \frac{x}{r} \right\} \right|_0^r$$

$$= \frac{\pi}{4} b^2 c + \frac{\pi}{4} a^2 r + \frac{2}{3} \frac{\pi}{4} r^3 + \frac{\pi}{4} r^2 \frac{\pi}{2} a;$$

but $\frac{\pi}{4} b^2 c$ is the cylinder BF, diam. BC, and height CF.

$\frac{\pi}{4} a^2 r$ „ GD, „ DE „ CE,

$\frac{2}{3} \frac{\pi}{4} r^3$ is a sphere „ GE,

$\frac{\pi}{4} r^2 \frac{\pi}{2} a$ is a cylinder „ GE and height half the circumference of DE;

hence, the rule for midship sections with flat bottoms and circular bilges:—

The displacement = midship section, by half the length of the trochoid, + two cylinders BF, + two cylinders GD, + two spheres of diameter GF, + a cylinder of diameter GF, and height the circumference of cylinder GD.

If the vessel is longer than the trochoid, the displacement of the prismatic midship piece (= midship section × length of the prism), must, of course, be added to the foregoing.

FOR PARABOLIC SECTIONS (FIG. 2)

we may take the general equation $y^n = p^{n-1} x$,
n being a whole positive number.

The volume $\mho$ of solid BICD = vols. BICF + GKFD.

$$= \frac{\pi}{4} b^2 c + \int_0^{d-c} \frac{\pi}{4} (b - x)^2 dy,$$

dy being an infinitely small portion of the depth;

$$\therefore \mathrm{U} = \frac{\pi}{4} b^2 c + \int_0^{d-c} \frac{\pi}{4} (b^2 + x^2 - 2 b x)\, dy ;$$

but as $y^n = p^{n-1} x$, $x = \frac{y^n}{p^{n-1}}$, and $x^2 = \frac{y^{2n}}{p^{2n-2}}$.

$$\therefore \mathrm{U} = \frac{\pi}{4} b^2 c + \frac{\pi}{4} \Big| _0^{d-c} b^2 y + \frac{\pi}{4} \Big| _0^{d-c} \frac{y^{2n+1}}{(2n+1) p^{2n-2}} - \frac{\pi}{4} \Big| _0^{d-c} \frac{2 b y^{n+1}}{(n+1) p^{n-1}}$$

When $x = b$,

$$y = \mathrm{GD} = d - c,$$

$$\frac{y^{2n+1}}{p^{2n-2}} = b^2 (d - c),$$

$$\frac{y^{n+1}}{p^{n-1}} = b^2 (d - c).$$

$$\therefore \mathrm{U} = \frac{\pi}{4} b^2 c + \frac{\pi}{4} b^2 (d - c) + \frac{\pi}{4} \frac{b^2 (d - c)}{2n+1} - \frac{\pi}{4} \frac{2 b^2 (d - c)}{n+1}.$$

$$\mathrm{U} = \frac{\pi}{4} b^2 c + \frac{\pi}{4} b^2 (d - c) \left(1 + \frac{1}{2n+1} - \frac{2}{n+1}\right)$$

For the Common Parabola

$n = 2$, or $y^2 = px$.

Then $\mathrm{U} = \frac{\pi}{4} b^2 c + \frac{\pi}{4} b^2 \times \frac{8}{15} (d - c)$ = cylinder of diam. BC, and height CF + cylinder of diam. BC, and height $\frac{8}{15}$GD.

When $n = 3$, or $y^3 = p^2 x$,

$$\mathrm{U} = \frac{\pi}{4} b^2 c + \frac{\pi}{4} b^2 \times \frac{9}{14} (d - c),$$

&c., and the

Displacement = area of midship section,

by the length of the trochoid + twice U.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(*Continued from page* 211.)

In connection with the meeting of the British Association in Nottingham, a visit was paid to the extensive works of the Butterley Company. The extent of these works may be estimated from the circumstance that they employ something like 6,000 workmen and boys, and that a sum exceeding £6,000 is paid weekly in wages. The first portion of the works visited was the timber yard at Butterley, where sawing by steam-power is carried to the highest perfection. The trunk of an oak-tree was brought in a wagon and placed under the saw, which was 54in. in diameter, and in less than two minutes a plank 16ft. in length and 2ft. in width was cut from the trunk with the greatest ease. The saw was made two years ago in Sheffield, when it measured 60in. in diameter; but constant work has reduced it to the dimensions stated. It should be mentioned that the Company build their own wagons and trucks, and that at the present time they have 1,500 of the latter in use, and 800 of the former, in conveying their produce of the collieries and ironworks to different parts of the kingdom. The steam saws are driven by a 15-horse-power horizontal engine. From the timber-yard the visitors proceeded to the furnaces, where iron is extracted from the ironstone with which the district abounds. We will endeavour to explain this process as briefly as possible, though to do it effectually and at length we should require at least ten times the space at our disposal. The ironstone having been brought from the mine, it is spread out in the yard, and, layers of coal being placed between it, at the rate of one hundred-weight to a ton, the coal is fired and the ironstone "burnt;" this process being adopted to oxidise, and at the same time extract the moisture from it. When this has been done, the ironstone is ready for the furnace, and is then placed in huge iron circular vessels, with a loose bottom, so that when run on a truck into the furnace the contents may be readily dropped into the glowing mass. The iron extracted from the stone accumulates on the hearth of the furnace, until it is drawn off into pits, from which it is lifted in "shanks," or iron vessels for casting. The furnace inspected has the air pumped into it by two engines of 100-horse power each, the pressure being 3lb. to the square inch; and the blowing cylinder is 70in. in diameter, with a 10ft. stroke. The air is forced by these engines through a number of pipes into a brick building called a stove, where it is heated to about 600 degrees, the melting temperature of lead, and then passes into the furnace through blow-pipes called "tuyeres." The boilers are fed by the waste gas from the furnaces, as far as it can be utilised, and, when this is not to be obtained, the consumption of coal is at the rate of 600 tons a month. There are six boilers, four on one side the engine and two on the other side. Having passed through the casting-room, the visitors returned to Codnor Park, where they had an opportunity of inspecting the Ironville Mechanics' Institution, which has been erected for the use of the workpeople by the proprietors. It consists of library, lecture-hall, and coffee-room, and is admirably adapted for the purposes for which it was designed. The company then passed through the workmen's new model lodging-house, the blast-engine premises, the refineries, the puddling furnaces, ball furnaces, sheet-mill, merchant and plate mills, the new puddling forge, the welding shop, and the new patent rolling mill; the whole of the extensive workshops being thrown open to the visitors. In these buildings the iron obtained from the stone at Butterley is manufactured into various articles. A large mass of red-hot iron weighing about a hundredweight was taken from a furnace, placed under a steam hammer, and beaten into the form of a bar. It was placed between massive iron rollers, which, being brought into closer proximity, rolled the bar into sheet iron. Railway sleepers were also beaten into shape by a large steam hammer, the blow of which is equal to 15 tons, and then passed through large massive rollers to give them the exact pattern required. As these castings were too long, the ends were cut off by a steam saw with the ease that a lady would cut off a thread from her work. The manufacture of pig iron, sheet and bar iron, and massive blocks for the sides of iron-plated vessels and bridges, as well as the welding of enormous bars of metal, were also shown to the visitors. The extent of the works, the magnificent character of the machinery, and the manner in which human labour is economised by mechanical applications were themes of universal admiration. Mr. J. G. N. Alleyne, the superintendent of the works, conducted the party through the whole of the premises, and explained the various principles in a very obliging manner. The productions of the works and the different applications of the machinery are ably described by Mr. Alleyne in the following paper, which he read to the company:—

Description of the Butterly Company's Works.

Having been requested by the members of the committee to draw up and read a short paper, descriptive of the various manufacturing operations which have this morning been inspected by the members of the British Association and others of our friends and neighbours, bearing in mind that many of them are ladies and non-professional gentlemen, I shall endeavour to take all the departments in the order in which they necessarily follow oach and which they have been inspected, avoiding as much as possible any difficult mechanical details, and making the explanation as general as possible. The sections this morning exhibited explain the positions of the various strata through which the coal and ironstone "pits" are sunk. The seams of coal and ironstone are reached by means of the shafts, galleries, and treadings, which have been inspected. The coal and ironstone are dug out by the miners, placed on small tramways, and drawn by ponies and horses, in some cases by steam power, to the bottom of the shaft, where they are raised by the winding or hoisting engines to the surface. There they are it is again loaded on to railway wagons for sale or consumption at the works. The method of supporting the roof of the mine, by means of props or "junctions," as they are technically called, is best understood by observing the way in which they are used in the mine. The miner, having removed a certain portion of the coal or ironstone, wedges these props tight between the "roof" or stratum just above the coal, and the "floor" or stratum immediately below it, so as to support the "roof," while a further quantity is excavated and removed. He then fixes more props and proceeds with his excavation. As his work advances he can allow the roof to fall. The props in the rear of his work are knocked out and used again in the front, except in the use of gangways or air-ways, the work in his rear being abandoned and allowed to fall. The saw-mill, which has also been inspected, is for the purpose of preparing the wooden props, cutting up timber for underground wagons; those used on the railways, and other purposes. Some idea may be formed of the quantity of timber required when I state that the company have at the present time running on various railways all over the country over 2,000 wagons, besides those that are required for conveying materials to the various departments of the works.

The Coke Hearth.—The ironstone, after being raised from the mine, is built up in heaps at the colliery, and allowed to "weather;" that is, it is exposed to the action of the sun, rain, and frost, until the clay or bind which adheres to it when it comes from the mine falls off. It is then brought to the coke hearth, and heaped up in alternate layers of coal and ironstone, the various qualities of ironstone to produce certain qualities of iron being mixed in due proportions as required, the principal kinds of ironstone used being the black, brown, and blue rakes. The heaps being thus prepared with layers of coal, are set on fire. They burn slowly for many weeks, and are allowed to cool before the ironstone is used in the smelting furnaces. The object of this process of "calcining," as it is called, is to set free the sulphur and phosphorus contained in the ironstone; the action of the air and rain-water conduce further to this end. When the burnt mass has cooled down it is ready for the blast furnace: it is then put into the filling apparatus, which is so contrived as to weigh each kind of material used in the furnace; they are all mixed in exact proportions. The coal being always a fixed quantity of nine hundredweight in each charge, the charge of ironstone varies, according to the quality of iron required and other circumstances, from nine hundredweight to eleven hundredweight. On an average, about three tons of ironstone produce one ton of pig iron. The ironstone is smelted with limestone, which acts as a fuse, the clay and earthy matter combining with the lime, and forming the slag which floats on the melted iron at the bottom of the furnace, and runs off at the lower part above the iron. The iron is smelted in the blast furnace, and runs out in the form of pig iron. At the Butterley Works this is again melted, and made into castings for machinery, bridges, and other purposes; at the Codnor Park Works it is manufactured into wrought iron. The air for the smelting operations is forced into the furnace at a pressure of from $2\frac{1}{2}$lbs. to 3lbs. on the square inch, by the blowing engines of 200-horse power.

The waste gases not used at the bottom of the furnace are drawn off by means of a high chimney before they get to the top of the furnace, whence they are conducted in tubes under the steam-boilers, and also into the stoves for heating the air as it is forced from the blowing cylinders into the furnaces. It is driven into the furnaces at a temperature of about 600 degrees Fahrenheit. The castings produced in the foundry are then passed on to the "engine factory," where they are turned, bored, and fitted to their places in the engines and other machinery of which they are destined to form a part. The boiler-yard, next visited, is a department of this factory, where boilers for steam-engines, bridges, roofs, and other works are manufactured from wrought iron supplied from the Codnor Park Works.

The Codnor Park Works.—Having made the pig iron in the blast furnace, which is a carbonising process, the first operation in the manufacture of wrought iron is to refine or decarbonise it. This is done by melting the iron, and while melted blowing a stream of air through and over it. The carbon contained in the pig iron combines with the oxygen of the blast, and passes away as carbonic acid gas. It is then run out of the furnace as refined iron. But in this process we have not got rid of all the carbon; we have got rid of some carbon, some sulphur, and some phosphorus. We must do more before we can get wrought iron. Cast iron contains more carbon than wrought iron or steel. Steel contains less than cast iron, and yet until the discoveries of Bessemer and others the system of making steel was first to make wrought iron—that is, to decarbonise the pig iron until it was wrought iron—and then, by a very costly and slow process, to recarbonise it for making steel, by the use of charcoal and other material. I believe that no one has at present succeeded with the Bessemer process on the clay ironstone; but with the hæmatites he has succeeded splendidly in getting steel directly from pig iron; stopping his operations when he has driven off enough carbon to make steel, but before he has driven off so much as is necessary to make wrought iron. The next operation after the refining is the

Puddling Furnace.—Here the iron is melted again, and stirred vigorously by the puddler and his assistants. It is mixed with the oxygen in the air passing over the surface of the melted iron. The carbon combines with oxygen, the iron gets thick and pasty, and when it has parted with the proper quantity of carbon it sticks together like a snowball. It is divided by the puddler into balls; it is then taken to the hammer and "shingled," or beaten into such a form that it can be rolled; it is then passed through the rollers of the mills, and rolled into bars; it is then cut into short pieces at the shears, and passed on to the

Ball Furnace, where these pieces are piled on one another, with an admixture generally of old iron, and of the ends of finished iron cut off at the last process, to be hereafter described. The piles so made are then heated, brought out, hammered, and rolled. It is again cut up at the shears, piled as before, and passed on to the merchant or finishing mills, to the plate mills, or wherever it may be required. Iron so made is the best iron. The iron called crown iron is made of alternate layers of ball furnaced iron and that which has only been puddled. The piles made as described are now handed on to be finished for the market, and are distributed to those mills which have been visited in order—the sheet mill, the small merchant mill, the joist and rail mill, and the plate mill, also to the steam hammer, where axles, shafts, and such articles are manufactured.

The Sheet Mill.—The iron prepared as before described is here rolled into sheets, and cut at the shears to the dimensions ordered.

The Merchant Mills.—The iron is here rolled in groove-rollers of the various sizes required, whether round or square, the various forms being produced by the shape of the grooves. When the sizes of any one description are finished, the rolls are removed and another set put into their places.

The Rail and Joist Mill.—This is a reversing mill. In all the mills hitherto visited, the iron being light, is lifted overthe rollers, but in this case the iron is so heavy that it is necessary to reverse the rollers. A great deal of time is saved in this way; the iron is finished at a much greater heat, when it is softer, and consequently when there is much less strain on the machinery. This mill and the plate mill were not originally assigned as reversing mills; but the increasing demands for heavy sections for ship-building, joists and girders for fire-proof floors, &c., made it necessary to put in the present reversing gear in the best way that could be devised. The iron, angle iron, rails, joists, and some of the smallest sections of ships' beams, are manufactured in this mill. In the mills hitherto inspected the iron is cut when cold, but in this case it is sawn while it is still hot.

The Plate Mill is the mill next visited, where plates for boilers, ships, bridges, and for other purposes are manufactured. This is also a reversing mill, altered from an ordinary mill in the same way as that on the other side of the engine. This engine, of 120-horse power, is an expansive condensing engine; it drives no less than four mills, one set of saws, and three pairs of shears. The plates, after being rolled, are allowed to cool, and are then cut at the large shears to the sizes required.

The Steam Hammer.—The iron in this case is somewhat differently worked. After being prepared at the puddling and ball furnaces, it is cut up and hammered into square lumps, built on to the shaft or other work piecemeal, instead of being made into piles and heated all at once, as is the case with rolled iron.

The Welding Process.—The demands for her Majesty's ships by the Admiralty were of such a size that, with the machinery then existing, it was out of the question to roll the beams for the *Warrior, Black Prince*, and ships of that class in one piece. A patent was taken out by Mr. David Warder, in the employ of the Admiralty, for welding two pieces of the iron through the whole length of the beam. The only means then known of doing such work was by applying the small welding furnaces, invented and patented by Mr. William Bertram, formerly of Woolwich dockyard. A number of experiments were tried, extending over many weeks, but it was found impracticable to keep the two pieces of iron one over the other; they expanded with the heat, and it was hopeless to make a sound weld. The whole attempt was about to be abandoned, when the writer thought of introducing between the two pieces an intermediate piece in the shape of the letter H. This held the iron together sideways, but allowed it to expand endways. This entirely overcame the difficulty, a patent was obtained for this mode of connecting the two pieces; it then only remained to design and make proper machinery for carrying on the work, and the trade in the patent welded beams was established. For light beams this process was too expensive, and it was found that to get them into the general market they must be rolled in one piece. As I have said it was out of the question to do such work in the old mills, and it was determined to put up an entirely new set of works, with puddling and ball furnaces complete.

The New Forge and Patent Rolling Mill.—The engine which drives this is of 120 horse power high pressure. The wheels and gearing of the old works are entirely dispensed with; the engine is connected right on to the rolls. The furnaces are arranged round a circle, of which the steam shingling hammer is the centre. Boilers are fixed over each furnace, so that no coal is used for making steam, the engine hammer and shears being driven entirely by the waste heat.

The New Patent Rolling Mill.—The furnaces in this mill are in new form, arranged with two high-pressure boilers over each. All the engines in this mill are worked by the waste heat. The furnaces are arranged in echelon in such a way that rails can be and are laid from the moving portion of the floor or platform to each furnace, the iron from which, when too heavy for the men to pull out, is drawn out by the machinery itself, the rails on the floor coinciding with those on the platform. The engines for driving this mill are of 120-horse power each. They are worked in opposite directions, and the mill is connected alternately with each. The fly-wheels are light in proportion to those generally used in rolling mills. If a piece of iron becomes jammed in the rolls, the breaking spindle gives way, if the stoppage is very sudden, or the engine is pulled up and the machinery is not injured. Before this system of engines and platform was patented and set to work, the plan proposed by Mr. Nasmyth, of reversing the engines themselves, was well considered. But it was thought, and practice has proved, that there is an enormous advantage in a moderate fly-wheel. As is illustrated, when a piece of iron gets jammed in the grooves, in removing it the speed can be reduced to a minimum, and the mill moved only a portion of an inch at a time, by throwing the crutch in and out of gear. The engines are so arranged that in a few days the fly-wheels can be disconnected and the machinery worked on Mr. Nasmyth's plan; but three years' practice has confirmed the opinion that where grooved rollers are necessary a moderate fly-wheel gives a command over the machinery which cannot be got in any other way. The iron, being previously heated, is drawn on to the platform and passed through one groove; it is received by that on the opposite side, moved sideways to the next groove and back again, when the mill is reversed, and so on until it is finished. It is then moved to the saws by the patent platform, and patent traversing rollers cut to the required lengths, and allowed to cool; it is then removed to the hydraulic presses and straightened, or, if a ship's beam, it is curved to the proper form of the deck. If it is required to have knees to fit against the frames of the ship, it is sent to the welding shop, where the knees are formed and welded in by the machinery which has been before inspected.

LOCOMOTIVE ENGINES AND CARRIAGES ON THE CENTRE RAIL SYSTEM FOR WORKING ON STEEP GRADIENTS AND SHARP CURVES, AS EMPLOYED ON THE MONT CENIS SUMMIT RAILWAY.

By Mr. Fell.

Mountain ranges have hitherto presented almost impassable barriers to the advance of the railway.

The Apennines, the Pyrenees, the Sommering in Austria, and the Ghauts in India, have, it is true, been crossed by the locomotive, and one gigantic tunnel is now in progress for connecting the railways of France with those of Italy.

The works of those undertakings are, however, of such a character as heavily to tax even the resources of a nation, and a plan by which mountain ranges could be traversed by railways, combining at once safety and economy, is a problem which remains to be solved.

Various methods have been proposed for accomplishing this important object. Amongst others are the rack and pinion, the pneumatic tube, an ingenious arrangement of ropes by Signor Agudio, and the system of traction by means of the centre rail.

The object of this paper is not to enter into the comparative merits of these different plans, but simply to describe the peculiarities and powers of the centre rail system, to furnish an account of the results of a long series of locomotive experiments made in England and France, and to invite discussion on a subject of scientific and public interest.

The use of the centre rail appears to have been first thought of by Messrs. Vignoles and Ericsson in the year 1830, and proposed by them to be applied to the inclines of the Liverpool and Manchester Railway. It was not, however, put into operation, being afterwards found on those gradients to be unnecessary.

In ignorance of what had been designed by those gentlemen more than thirty years ago, the Baron Seguier, in France, the writer and others in England and elsewhere, consider themselves also to be inventors of the centre rail system. The idea is so natural and so well adapted to the purpose that it is not surprising it should have occurred simultaneously, or at various periods, to different persons independently who were seeking a solution of the problem of constructing railways over mountain passes and on steep gradients.

But it was not until Mr. Brassey and myself built a centre rail engine and laid down a length of line on that plan on the Cromford and High

Peak Railway, for experimental purposes, in the autumn of 1863, that the system had ever been pnt into practical operation, at least in Europe.

The locomotive trials in question were made under the following circumstances:—

About four years ago the Italian Government entered into a convention for a service of mail steamers from the port of Brindisi, on the Adriatic, to Alexandria, and gave concessions for continuing their lines of railway to the former port, thus completing, with the exception of the passage of the Alps at the Mont Cenis, a new and more expeditious route from this country to India and the East. The great tunnel commenced for the purpose of connecting France with Italy, forming the last link in this line, required many years for its completion, and the writer being in Italy at the time was asked to furnish a plan by which this apparently insurmountable obstacle could be overcome at an earlier period.

In conjunction with Mr. Brassey and some other gentlemen who appreciated the importance of the undertaking in a national point of view, he proposed to construct a railway on the existing imperial road, a distance of forty-eight miles from St. Michel, the present terminus of the French railways, to Susa, Piedmont, where at the southern base of Mont Cenis the Italian lines begin, and so put into early communication the existing lines of the two countries, and complete the new route to the East, whereby a saving of thirty-eight to forty hours could be effected in the transit of the Indian mail.

The two Governments accepted the proposal on the condition of their being satisfied as to the practicability of working locomotives on gradients as steep as those of the public road, combined with sharp curves, and at such an elevation as the summit of this Alpine pass.

The mean gradient of the first twenty-four miles of the line from St. Michel to Lanslebourg is 1 in 60, with a maximum gradient of 1 in 12; of the other twenty-four miles the mean gradient is 1 in 17, the maximum being also 1 in 12, and over the whole length there are at intervals curves of 40 metres or two chains radius.

The line rises to an elevation of nearly 7,000ft., and is, consequently, exposed in places to avalanches and heavy snow drifts, where it will be protected by suitable masonry or timber-covered ways.

The whole question, therefore, resolved itself into the practicability of constructing locomotive engines capable of performing the service.

It is evident that no ordinary locomotive could carry traffic on gradients of 1 in 12 in a climate where the co-efficient of adhesion falls at times below a tenth, or even a twelfth, of the weight of the engine. No amount of weight added to the engine would give it the power of drawing any load beyond itself up such inclines under such circumstances, and it became indispensable to obtain an increased amount of adhesion by means altogether independent of weight.

Various plans proposed for this purpose were considered—such as the rack and pinion, and grooved wheels; but the system adopted has been that of a third, or traction rail, on which adhesion could be obtained by the pressure of horizontal wheels worked by the engine in conjunction with, or independently of, the ordinary driving wheels.

This plan admits of the weight of the engine being reduced to a minimum, while the pressure upon the middle rail, and, consequently, adhesion, can be carried to any amount that may be required, and gradients of 1 in 12 be worked with as much certainty and safety as those of 1 in 100.

The centre rail also furnishes the means of applying most powerful brakes for controlling the descent of the trains on the steep inclines, and, by the guiding action of the horizontal wheels, greatly diminishes the frictional resistance in passing round sharp curves.

Another, and not the least important, of the advantages of the centre rail system is the great additional security which it affords, rendering it almost impossible for engines or carriages to leave the rails.

The first series of experiments were made by the permission of the London and North-Western Railway Company on the Cromford and High Peak Railway from September, 1863, to February, 1864. The engine had two outside and two inside cylinders arranged for driving the vertical and horizontal wheels independently one of another. The diameter of the former was 27in., and of the latter 16in. The boiler contained 420ft. of heating surface, and the grate area was 6ft. The weight of the engine light was 14 tons 8 cwt., and loaded from 16 tons to 17 tons.

The principal object of these trials was to prove the practicability of obtaining effective adhesion by the pressure of horizontal wheels on the centre rails, and of testing the facilities afforded by them for passing round sharp curves. These points were satisfactorily established, the engine never having failed to take loads of 16 to 24 tons up gradients of 1 in 12, working round curves of $2\frac{1}{2}$ chains radius on that incline with the greatest ease, the brakes having perfect control over the train on the descent.

The necessity of certain improvements, however, had shown themselves in the course of these trials: the boiler-power was insufficient to carry the load at the speed required, the inside machinery was too much crowded and inaccessible, and the connecting rods, working at too great an angle, by an irregular impulsive movement, diminished the adhesion of the horizontal wheels.

The second series of trials was made from the month of February to July last year; during the latter months with an improved engine specially designed for carrying the loads and running at the speeds required by the programme accepted as the basis of the undertaking by the French and Italian Governments. It was proposed to carry the existing traffic by three trains a day each way—namely, a mail-train drawn by one engine, a mixed train with two engines, and a goods train also with two engines. The mail-trains were to perform the journey in $4\frac{1}{2}$ hours, including stoppages, or at an average speed of travelling of 12 miles an hour; the speed on the steepest gradient being fixed for ascending and descending at 12 kilometres, or $7\frac{1}{2}$ miles per hour, the gross weight of the train being 16 tons.

The mixed trains were allowed 6 hours, and the goods trains 8 hours for the journey, the weights being respectively 40 and 48 tons. The passengers, mails, and goods carried in these trains represented a traffic of 2,500,000 francs, or £100,000 sterling per annum.

The site of the experimental line was chosen by the French Government, and fixed on a portion of the road between Lanslebourg and the summit, at an elevation of about 5,600ft. above the sea. The length is 2 kilometres, or $1\frac{1}{4}$ miles. The average gradient is 1 in 13, and about half a mile is on curves from 40 to 150 metres radius.

The trials were made in the presence of Captain Tyler, R.E., Commissioner for the English Government, and also commissions of engineers appointed by the French, Italian, Russian, and Austrian Governments.

The result of the official trials given in the accompanying tables show that the average speed attained for the mail train was $15\frac{1}{2}$, instead of 12 kilometres, per hour, and for the goods train $10\frac{1}{2}$, instead of 6 kilometres, per hour, while the steam-pressure increased 20 to 25 pounds each run up the line; consequently the power developed was sufficient to carry a mail train of 24 tons, instead of 16 tons, and a goods train of 50 tons, instead of 24 tons, at the speed required.

There can be no doubt that Captain Tyler has rendered an important public service by the trouble he has taken in thoroughly investigating the centre-rail system, both as to its application to the passage of the Mount Cenis and generally with regard to its safety and its mechanical and commercial capabilities.

(To be continued.)

THE MEASURED MILE IN THE FRITH OF CLYDE.

Messrs. R. Napier and Sons having long felt the want on the Clyde of a correct measured nautical mile for testing the speed of large steamers (similar to what the Admiralty have near Portsmouth and elsewhere), they had the shores of the Clyde examined for a suitable place for laying off a knot, and finding that from Skelmore pier, southwards, would answer the purpose, they applied to the Right Hon. the Earl of Eglington, for liberty to erect beacons on his property. This the Earl at once most kindly gave full permission to do. Messrs. Napier then employed Messrs. Kyle and Frew, along with Messrs. Smith and Wharrie, land surveyors, Glasgow, to measure and lay off a knot, which they did; and thereafter they made application to the Lords Commissioners of the Admiralty, begging as a favour that they would send one of their officers to re-measure and test the correctness of this knot, and that they would willingly bear the expense. Their lordships were pleased to accede to the request, and afterwards intimated to Messrs. Napier that the knot had been duly tested by their officers, and found correct—at the same time they declined to make any charge. Their lordships have caused a printed notice to mariners to be issued from the Hydrographic Department of the Admiralty, describing the position of these beacons.

ROYAL INSTITUTION OF GREAT BRITAIN.

(*Continued from p.* 231.)

ON THE SOURCE OF MUSCULAR POWER.

By EDWARD FRANKLIN, Ph.D., F.R.S., Professor of Chemistry, R.I.

PLAYFAIR'S DETERMINATIONS.

In these determinations the number 109,496 metrekilograms was obtained as the average amount of daily work performed by pedestrians, pile-drivers, porters, paviours, &c.; but, as the amount of muscle consumption is calculated from the nitrogen taken in the food, the conditions are as unfavourable as possible with regard to the point the speaker was seeking to establish; for it is here assumed, not only that all the nitrogen taken in the food enters the blood, but also that it is converted into muscle, and is afterwards oxidised to carbonic acid, water, and urea.

The following are the results expressed as in the previous cases:—

Hard-worked Labourer.—(Playfair).

	Work performed.	Actual energy required.
Daily labour (external work)	109,496 mks.	218,992 mks.
Internal work	80,006 „	160,012 „
	189,502 „	379,004 mks.
Actual energy capable of being produced from 5·5oz. (155·92grms.) of flesh-formers contained in the daily food of the labourer	...	288,140 mks.

Thus, even under the extremely unfavourable conditions of these determinations, the actual work performed exceeded that which could possibly be produced through the oxidation of the nitrogenous constituents of the daily food by more than 30 per cent.

We have seen, therefore, in the above four sets of experiments, interpreted by the data afforded by the combustion of muscle and urea in oxygen, that the transformation of tissue alone cannot account for more than a small fraction of the muscular power developed by animals; in fact, this transformation goes on at a rate almost entirely independent of the amount of muscular power developed. If the mechanical work of an animal be doubled or trebled, there is no corresponding increase of nitrogen in the secretions; whilst it was proved on the other hand by Lawes and Gilbert, as early as the year 1854, that animals, under the same conditions as regarded exercise, had the amount of nitrogen in their secretions increased twofold by merely doubling the amount of nitrogen in their food. Whence then comes the muscular power of animals? What are the substances which, by their oxidation in the body, furnish the actual energy, whereof a part is converted into muscular work? In the light of the experimental results detailed above, can it be doubted that a large proportion of the muscular power developed in the bodies of animals has its origin in the oxidation of non-nitrogenous substances? For whilst the secretion of nitrogen remains nearly stationery under widely different degrees of muscular exertion, the production of carbonic acid increases most markedly with every augmentation of muscular work, as is shown by the following tabulated results of E. Smith's highly important experiments regarding the amount of carbonic acid evolved from his own lungs under different circumstances.*

Excretion of carbonic acid during rest and muscular exertion:

	Carbonic acid per hour.
During sleep	19·0 grams.
Lying down and sleep approaching	23·0 „
In a sitting posture	29·0 „
Walking at a rate of 2 miles per hour	70·5 „
„ „ 3 „ „	100·6 „
On the treadwheel, ascending at the rate of 28·65ft. per minute	189·6 „

It has been already stated as a proposition upon which all are agreed, that food, and food alone, is the ultimate source from which muscular power is derived; but the above determinations and considerations, the speaker believed, prove conclusively, firstly, that the non-nitrogenous constituents of the food such as starch, fat, &c., are the chief sources of the actual energy, which becomes partially transformed into muscular work; and secondly, that the food does not require to become organised tissue before its metamorphosis can be rendered available for muscular power; its digestion and assimulation into the circulating fluid—the blood—being all that is necessary for that purpose. It is, however, by no means the non-nitrogenous portions of food alone that are capable of being so employed, the nitrogenous also, inasmuch as they are combustible, and consequently capable of furnishing actual energy, might be expected to be available for the same purpose, and such an expectation is confirmed by the experiments of Savory upon rats,† in which it is proved that these animals can live for weeks in good health upon food consisting almost exclusively of muscular fibre. Even supposing these rats to have performed no external work, nearly the whole of their internal muscular work must have had its source in the actual energy developed by the oxidation of their strictly nitrogenous food.

It can scarcely be doubted, however, that the chief use of the nitrogenous constituents of food is for the renewal of muscular tissue; the latter, like every other part of the body, requiring a continuous change of substance, whilst the chief function of the non-nitrogenous is to furnish by their oxidation the actual energy which is in part transmuted into muscular force.

The combustible food and oxygen co-exist in the blood which courses through the muscle, but when the muscle is at rest there is no chemical action between them. A command is sent from the brain to the muscle, the nervous agent determines oxidation. The potential energy becomes active energy, one portion assuming the form of motion, another appearing as heat. Here is the source of animal heat, here the origin of muscular power! Like the piston and cylinder of a steam-engine, the muscle itself is only a machine for the transformation of heat into motion; both are subject to wear and tear, and require renewal, but neither contributes in any important degree by its own oxidation to the actual production of the mechanical power which it exerts.

From this point of view it is interesting to examine the various articles of food in common use, as to their capabilities for the production of muscular power. The speaker had, therefore, made careful estimations of the calorific value of different materials used as food, by the same apparatus and in the same manner as described above for the determination of the actual energy in muscle, urea, uric acid, and hippuric acid.

The results are embodied in the following series of tables, but it must be borne in mind that it is only on the condition that the food is digested and passes into the blood, that the results given in these tables are realised. If, for instance, sawdust or paraffin oil had been experimented upon, numbers would have been obtained for these substances, the one about equal to that assigned to starch, and the other surpassing that of any article in the table; but these numbers would obviously have been utterly fallacious, inasmuch as neither sawdust nor paraffin oil is, to any appreciable extent, digested in the alimentary canal. Whilst the force values experimentally obtained for the different articles in these tables must, therefore, be understood as the maxima assignable to the substances to which they belong, yet it must not be forgotten that a large majority of these substances appear to be completely digestible under normal circumstances.

* Phil. Trans. for 1859, p. 709.
† "The Lancet," 1863, pages 381 and 412.

Actual Energy developed by One Gram of various Articles of Food when burnt in Oxygen.

Name of Food.	Heat Units.		Metrekilograms of Force.		Per cent. of Water.
	Dry.	Natural Condition.	Dry.	Natural Condition.	
Cheese (Cheshire)	6,114	4,647	2,589	1,969	24·0
Potatoes	3,752	1,013	1,589	429	73·0
Apples	3,669	660	1,554	280	82·0
Oatmeal	...	4,004	...	1,696	...
Flour	...	3,941	...	1,669	...
Pea-meal	...	3,936	...	1,667	...
Ground Rice	...	3,813	...	1,615	...
Arrowroot	...	3,912	...	1,657	...
Bread Crumb	3,984	2,231	1,687	945	44·0
Ditto Crust	...	4,459	...	1,888	...
Beef (lean)	5,313	1,567	2,250	664	70·5
Veal „	4,514	1,314	1,912	556	70·9
Ham „	4,343	1,980	1,839	839	54·4
Mackerel	6,064	1,789	2,568	758	70·5
Whiting	4,520	904	1,914	383	80·0
White of Egg	4,896	671	2,074	284	86·3
Hard-boiled Egg	6,321	2,383	2,677	1,009	62·3
Yolk of Egg	6,460	3,423	2,737	1,449	47·0
Gelatin	4,520	...	1,914	...	...
Milk	5,093	662	2,157	280	87·0
Carrots	3,767	527	1,595	223	86·0
Cabbage	3,776	434	1,599	184	88·5
Cocoa Nibs	...	6,873	...	2,911	...
Beef Fat	9,069	...	3,841	...	...
Butter	...	7,264	...	3,077	...
Cod-liver Oil	...	9,107	...	3,857	...
Lump Sugar	...	3,348	...	1,418	...
Commercial Grape Sugar	...	3,277	...	1,388	...
Bass's Ale (alcohol reckoned)	3,776	775	1,599	328	88·4
Guinness's Stout	6,348	1,076	2,688	445	88·4

Actual Energy developed by One Gram of various Articles of Food when oxidised in the Body.

Name of Food.	Metrokilograms of Force.	
	Dry.	Natural Condition.
Cheshire Cheese	2,429	1,846
Potatoes	1,563	422
Apples	1,561	273
Oatmeal	...	1,665
Flour	...	1,627
Pea-meal	...	1,598
Ground Rice	...	1,591
Arrowroot	...	1,657
Bread Crumb	1,625	910
Lean of Beef	2,047	604
Ditto Veal	1,704	496
Ditto Ham, boiled	1,559	711

Name of Food.	Metrokilograms of Force.	
	Dry.	Natural Condition.
Mackerel	2,315	683
Whiting	1,675	335
White of Egg	1,781	244
Hard-boiled Egg	2,562	966
Yolk of Egg	2,641	1,400
Gelatin	1,550	...
Milk	2,046	266
Carrots	1,574	220
Cabbage	1,543	178
Cocoa Nibs	...	2,902
Butter	...	3,077
Beef Fat	3,841	...
Cod-liver Oil	3,857	...
Lump Sugar	...	1,418
Commercial Grape Sugar	...	1,388
Bass's Ale, bottled	1,559	328
Guinness's Stout	2,688	455

Weight and Cost of various Articles of Food required to be oxidised in the Body in order to raise 140lbs. to the height of 10,000ft.
External work = $\frac{1}{5}$th actual energy.

Name of Food.	Weight in lbs. required.	Price per lb.		Cost.	
		s.	d.	s.	d.
Cheshire Cheese	1·156	0	10	0	11½
Potatoes	5·068	0	1	0	5¼
Apples	7·815	0	1½	0	11¾
Oatmeal	1·281	0	2¾	0	3½
Flour	1·311	0	2¾	0	3¾
Pea-meal	1·335	0	3¼	0	4½
Ground Rice	1·341	0	4	0	5½
Arrowroot	1·287	1	0	1	3½
Bread	2.345	0	2	0	4¾
Lean Beef	3·532	1	0	3	6½
„ Veal	4·300	1	0	4	3½
„ Ham boiled	3·001	1	6	4	6
Mackerel	3·124	0	8	2	1
Whiting	6·369	1	4	9	4
White of Egg	8·745	0	6	4	4½
Hard-boiled Egg	2·209	0	6½	1	2½
Isinglass	1·377	16	0	22	0½
Milk	8·021	5d. per quart.		1	3½
Carrots	9·685	0	1½	1	2½
Cabbage	12·020	0	1	1	0¼
Cocoa-nibs	0·735	1	6	1	1¼
Butter	0·693	1	6	1	0½
Beef Fat	0·555	0	10	0	5½
Cod-liver Oil	0·553	3	6	1	11¼
Lump Sugar	1·505	0	6	1	3
Commercial Grape Sugar	1·537	0	3½	0	5½
Bass's Pale Ale (bottled)	9 bottles.	0	10	7	6
Guinness's Stout	6¾ „	0	10	5	7½

Weight of various Articles of Food required to sustain Respiration and Circulation in the Body of an aveage Man during 24 hours.

Name of Food.	Weight in oz.	Name of Food.	Weight in oz.
Cheshire Cheese	3·0	Whiting	16·8
Potatoes	13·4	White of Egg	23·1
Apples	20·7	Hard-boiled Egg	5·8
Oatmeal	3·4	Gelatine	3·6
Flour	3·5	Milk	21·2
Peameal	3·5	Carrots	25·6
Ground Rice	3·6	Cabbage	31·8
Arrowroot	3·4	Cocoa Nibs	1·9
Bread	6·4	Butter	1·8
Lean Beef	9·3	Cod-liver Oil	1·5
„ Veal	11·4	Lump Sugar	3·9
„ Ham, boiled	7·9	Commercial Grape Sugar	4·0
Mackerel	8·3		

These results are in many instances fully borne out by experience. The food of the agricultural labourers in Lancashire contains a large proportion of fat. Besides the very fat bacon which constitutes their animal food proper, they consume large quantities of so-called apple dumplings, the chief portion of which consists of paste in which dripping and suet are large ingredients, in fact these dumplings frequently contain no fruit at all. Egg and bacon pies and potato pies are also very common *pièces de résistance* during harvest-time, and whenever very hard work is required from the men. The speaker well remembers being profoundly impressed with the dinners of the navigators employed in the construction of the Lancaster and Preston Railway; they consisted of thick slices of bread surmounted with massive blocks of bacon, in which mere streaks of lean were visible. Dr. Piccard states that the Chamois hunters of Western Switzerland are accustomed, when starting on long and fatiguing expeditions, to take with them, as provisions, nothing but bacon-fat and sugar, because, as they say, these substances are more nourishing than meat. They doubtless find that in fat and sugar they can most conveniently carry with them a store of force-producing matter. The above tables affirm the same thing. They show that ·55lb. of fat will perform the work of 1·15lb. cheese, 5lbs. potatoes, 1·3lb. of flour or peameal or of 3½lbs. of lean beef. Donders, in his admirable pamphlet "On the Constituents of Food and their Relation to Muscular Work and Animal Heat," mentions the observations of Dr. M. C. Verloren on the food of insects. The latter remarks, "Many insects use during a period in which very little muscular work is performed food containing chiefly albuminous matter; on the contrary, at a time when the muscular work is very considerable, they live exclusively or almost exclusively, on food free from nitrogen." He also mentions bees and butterflies as instances of insects performing enormous muscular work, and subsisting upon a diet containing but the merest traces of nitrogen.

We thus arrive at the following conclusions:—

1. The muscle is a machine for the conversion of potential energy into mechanical force.
2. The mechanical force of the muscles is derived chiefly, if not entirely, from the oxidation of matters contained in the blood, and not from the oxidation of the muscles themselves.
3. In man the chief materials used for the production of muscular power are non-nitrogenous; but nitrogenous matters can also be employed for the same purpose, and hence the greatly increased evolution of nitrogen under the influence of a flesh diet, even with no greater muscular exertion.
4. Like every other part of the body, the muscles are constantly being renewed; but this renewal is not perceptibly more rapid during great muscular activity than during comparative quiescence.
5. After the supply of sufficient albuminised matters in the food of man to provide for the necessary renewal of the tissues, the best materials for the production, both of internal and external work, are non-nitrogenous matters, such as oil, fat, sugar, starch, gum, &c.
6. The non-nitrogenous matters of food, which find their way into the blood, yield up all their potential energy as actual energy; the nitrogenous matters, on the other hand, leave the body with a portion (one-seventh) of their potential unexpended.
7. The transformation of potential energy into muscular power is necessarily accompanied by the production of heat within the body, even when the muscular power is exerted internally. This is, doubtless, the chief and, probably, the only source of animal heat.

BOOKS RECEIVED.

"The Student's Text Book of Electricity." By Henry M. Noad, Esq. London: Lockwood and Co., Stationers' Hall-court, 1867.

"The Scientific and Literary Treasury." By Samuel Maunder, Esq. New Edition. London: Longman, Green, and Co.

We have received the above valuable works, though too ate for review until our next issue.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

WESTMINSTER BRIDGE.

To the Editor of THE ARTIZAN.

SIR,—Having seen paragraphs in some of the papers stating that the Commissioners of her Majesty's Works had refused permission for a heavy crank-shaft for the Hercules to be carried over Westminster Bridge, which paragraphs were accompanied by observations on the strength of the bridge, I think it right to state that when application was made to the Board of Works by Messrs. Pickford, they were referred to me; that I requested to be supplied with a diagram showing how the load was to be supported, and stated that 40½ tons had gone over the footway on six wheels, nearly seven tons per wheel, when half the bridge only was opened for traffic, and that there would be no difficulty in the proposed weight going over, now that the trams were completed for heavy weights; that Messrs. Pickford finally determined to pass the weight over Waterloo Bridge, without further reference to the Commissioners of her Majesty's Works, or myself, as engineer of the bridge.

If you will kindly insert this explanation, you will oblige,

Yours truly,

Oct. 25, 1866. THOS. PAGE.

NOTICES TO CORRESPONDENTS.

ARTIST.—Consult Dr. Ure's Dictionary. The prepared ox-gall can be obtained from any artists' colourman.

O. W.—A saturated solution of oxalic acid in water is the best specific for removing common ink from paper or fabrics. To remove Indian ink or copying ink, nitric or muriatic acid may be used.

PRACTICUS.—You are very much mistaken. Your rod would break in "less than no time." Its thickness should not be less than 2¼in. under any circumstances. The flange may be about ⅞in. thick.

D. K.—The weights generally used in Turkey are as follows:—

1 kantar=44 okas=100 rottoli=17,600=dramms.
1 kantar=124·46lb. avoirdupois.

In Greece the same system was in use in former days, but has been superseded by one based on the French metric weights, thus:

1 ton=10 talents=1,000 mines=1,500,000 drachmas.
1 ton=1,500 kilogrammes.
1 drachma=10 oboli=100 grains=1 gramme.

The French metric measures of length, surface, and capacity are also legal in Greece. The same were adopted in Roumania—if we remember rightly, by the Divan *ad hoc*—in 1857.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Sept. 29.			Oct. 6.			Oct. 13.			Oct. 20.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
COPPER.												
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	88	0	0	88	0	0	88	0	0	86	0	0
Copper wire, per lb.	0	0	11¾	0	0	11¾	0	0	11¾	0	0	11¾
„ tubes, do.	0	1	0¼	0	1	0¼	0	1	0¼	0	1	0¼
Sheathing, per ton	91	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	7	2	6	7	2	6	7	2	6	7	2	6
Nail rods, do.	7	10	0	7	10	0	7	10	0	7	10	0
„ Stafford in London, do.	8	10	0	8	10	0	8	10	0	8	7	6
Bars, do.	8	10	0	8	10	0	8	10	0	8	7	6
Hoops, do.	9	5	0	9	5	0	9	5	0	9	5	0
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	15	6	2	15	6	2	15	6	2	15	6
LEAD.												
English pig, ord. soft, per ton	20	5	0	20	5	0	20	5	0	20	5	0
„ sheet, do.	21	10	0	21	10	0	21	10	0	21	0	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	10¼	0	0	10¾	0	0	10¾	0	0	10¼
Wire, do.	0	0	9½	0	0	9½	0	0	9½	0	0	8¾
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	7	0	0	7	0	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	14	0	1	14	0	1	14	0	1	14	0
IX „ „ „	2	0	0	2	0	0	2	0	0	2	0	0
IC „ 2nd qua., „	1	10	0	1	10	0	1	0	0	1	10	0
IC Coke, per box	1	4	0	1	4	0	1	4	6	1	4	6
IX „ „	1	10	0	1	10	0	1	10	0	1	10	6

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE LOCOMOTION OF FISHES.—The views of M. Ferd. Monoyer are not without interest. The movement of fishes through the water takes place, he says, by the action of the tail, and principally of the caudal fin. When the progression is rapid, the other fins play no part in locomotion. When the fish wishes to stop, it does so as an oarsman would, by producing "backwater," which it effects through its pectoral fins. The other fins may be employed in this latter operation, but their only use is to prevent the fish turning round on its transverse axis.—*Popular Science Review.*

ONE OF THE LIMITS OF MAN.—Man cannot distinguish a space of time that may be less than the tenth part of a second.

CANADA.—The prosperous state of Canada looks propitious for her railways. The surplus of her revenues for the year ending 30th June, 1866, shows an increase of 180,000,000 dollars over the exports and imports of the previous year.

WATER WORKS.—New waterworks have been commenced at Port Glasgow.

STEEL FERRULES are in increasing demand for boiler-tubes.

HEAT.—The temperature of 2,870° C has been got by M. Schlœsing. He regulates the quantities of hydrogen-gas and of air brought together for combustion. The hydrogen obtained from decomposed water, he causes to pass over incandescent charcoal, before it arrives at the place of combustion, where it meets the necessary proportional of air.

SODIUM.—The many serious accidents which have recently occurred with nitro-glycerine have disposed nautical men to look on every package labelled "chemicals," with a considerable amount of suspicion, if not actual dread. Some time since a box of about 30lbs. weight was being passed on board a steamer on the Pacific, *in transit* for California. The anxious mate discovered on it the words "Sodium," "Chemicals." He saw at once dog-Latin for an explosive mixture, and ordered the men to "pass it overboard," but what was his astonishment to see an immense amount of flame burst up on the water as in revenge for his fears, and that so close as to put the ship, and all on board, in the utmost peril. Chemicals command respect, as they can and do punish ignorant meddling, and that severely. Sodium has recently been introduced into California, and by its judicious use, considerably increased the yield of gold. Our readers are aware that this metal sodium inflames on contact with water, and being lighter than water floats on its surface. The "sodium amalgam," does not decompose water, and therefore does not inflame when in contact with it, the sodium being now saturated with another metal, probably quicksilver.

THE NON-RECOIL GUN.—This gun of Mr. G. P. Harding, being a simple tube, has been exposed to the *fanfarade* of the jester in the absence of some explanation. We have received the following, and it may be correct for ought we *know* to the contrary. The shot is placed at the centre, the charge behind is confined by a wad, whilst a second wad is introduced at such a distance as to *leave an air-space behind the charge.* It is confidently asserted, that, although the tube is equally open in both directions, almost the whole force of the explosion takes effect on the shot, which attains the *same velocity* as if fired from an ordinary gun, and is followed by the gases generated in the gun, a very small part only escaping at the breech. Mr. Harding's theory appears to be this; that compression of the air in the space behind the charge occupies an appreciable time, during which the force of the explosion has been communicated to the shot. It appears, that, although Mr. Harding had fired off this gun without a breech hundreds of times, he does not appear to have accumulated statistics enough to publish. How many inch boards (fir) can an ounce ball penetrate at 100 yards from his gun when fired, &c.?

HYDRAULIC RAMS.—The friction of the packing leathers has been decided by elaborate experiments conducted by Mr. John Hick, C.E., Bolton. The friction increases in direct proportion to the diameter, or with the square root of the respective gross load. The whole friction is produced where the leather emerges from the recess, and begins to lean against the ram. With leather collars, and a 4in. ram, the leather being quite new and stiff, and sparingly lubricated, show the greatest friction to be 1·55 per cent. of the pressure on the area of 12·56 sq. in., and the smallest friction as 1·07 per cent. Forty-eight experiments with leather collars, before in use and well lubricated, give an average friction of 0·72 per cent. of the pressure on the 4in. ram. Some rose so high as 1 per cent., and others ranged as low as 0·5.

COALS IN CHINA.—We hear that there is an excellent bed of coal of very fine quality, accessible to points where the Celestials have, hitherto, been in the habit of importing their fuel from Great Britain.

THE ROYAL OBSERVATORY.—A new set of instruments are being erected at the Observatory, by Mr. John Browning, under the supervision of the Astronomer Royal and Mr. Glaisher, for registering the speed and pressure of the wind. That for registering the force, consists of a circular plate of metal, of 2ft. area, which presses against eight steel springs, which are brought consecutively into action. The plate is self-adjusting, to face the wind. From the plate a wire is carried down through the hollow pillar which supports the plate and vane, into a room below. There the wire gives motion to a pencil which traverses a slate table covered with a sheet of paper, marked to represent the hours. The table is moved by clockwork, from one of these marks to the next, every hour. Thus every variation, and the time, is noted throughout the twenty-four hours. The pressure varies from two to three ounces per square foot up to 40lbs. The instrument for measuring the velocity of the wind consists, essentially, of four hollow hemispherical cups, attached to arms, and a central spindle, which carries them. These revolve at one third of the velocity of the wind. The motion of the spindle is reduced by a train of wheels, and the register is by indices on graduated circles, showing respectively tenths of a mile, tens of miles, and hundreds of miles. A rack motion communicates by means of a rod,

with a pencil in another room. This pencil traverses a paper, which is strained on a cylinder, and the cylinder revolves by clockwork. This paper also is lined to represent hours, and the pencil registers automatically and continuously, the velocity of the wind by day and night. At Greenwich, the velocity seldom exceeds 800 miles in the twenty-four hours, but at Liverpool and other sea-ports, greater speeds occur. This arrangement will facilitate a tabulated record of the force and velocity of the wind, for years to come.

Petroleum and Coal Oil as Fuel.—The proper function of coal oil as fuel is precisely analagous to that of the emergency sticks of firewood usually employed for the purpose of getting up a kitchen fire at a few minutes' notice. As a means of getting up steam rapidly, the oil fuel, or fluid coal as we may properly call it, is unquestionably superior to the solid coal, and its superiority in this respect is due to the same property which gives the superiority to the firewood—viz., its immediate flaming. The temperature of a clear flame is equivalent to a white heat, and a boiler enveloped in flame has white-hot fuel in actual contact with all the exposed portion of its surface—a condition obviously unattainable with any sort of solid fuel burning without flame. The emergencies in which the rapid getting up of steam, or the sudden putting on an extra pressure, is required, are numerous and important. With auxiliary screw ships, when steam is only used during calms, contrary winds, and other special occasions, it is of the utmost importance to lose no time when the steam is required at all. A ship drifting towards a lee shore by an overpowering wind may be saved by an expeditious use of steam power. It is very probable that when this kind of fuel is practically understood, sailing ships will be commonly supplied with steam power to be used only on special emergencies, and the small bulk of fluid fuel required be permanently stored in tanks occupying the vacant spaces on the ship's sides. In warfare, the importance of suddenly getting up steam and putting on the maximum of pressure is incalculable. To talk or think about the extra cost of fuel under these circumstances is simple absurdity. Victory or defeat must now depend upon the manœuvring of ships of war, since modern artillery defies all kinds of armour when a shot can be fired point-blank at the ship's sides. In blockading or blockade-running, and all kinds of cruising enterprises, such as those on the slave-dealing coasts of Africa, &c., a means of getting up steam suddenly will effect an immense economy, even though the fuel for this purpose costs ten times that of common coal, inasmuch as it may remove the necessity for continual keeping up of steam. Many other cases might be named, not only at sea, but on shore, where a flashing fuel is of the greatest value; and if inventors would direct their attention to the construction of an auxiliary furnace by which such fuel could be applied, either alone or in conjunction with the ordinary coal, we have little doubt of their success, and that oil-makers will thereby find a market for all the heavy oil they can possibly produce at a fair remunerative price. —*Oil Trade Review.*

Oil in Brazil.—Specimens of a new oil-yielding mineral found in large quantities about eighteen miles from Bahia have lately been brought to England. This mineral forms a porous substance, pale grey in colour, and as light as pumicestone. If white paper be marked with it, it imparts a rich brown colour scarcely a shade lighter than that imparted by a piece of our boghead mineral. It yields an average of eighty gallons to the ton of raw material, which, on account of its light nature, represents such a large bulk that it would not be profitable to ship it to distant places, although the proportion of oil yielded would "pay" well if extracted on the spot. It lies in seams several feet in thickness, and within a very short distance of the seaboard, and, like our Scotch shales, it is found at various depths and in variable thicknesses and qualities. In outward appearance it is totally unlike any oil-yielding material which has been brought under our notice, and we understand that some samples were lately examined with great interest by Sir Roderick Murchison and the commissioners lately appointed by royalty to inquire into our coal supplies. We believe a company is being formed in London with the object of establishing retorts on the spot where the mateiral has been found.—*The Oil Trade Review.*

French Notions of Comfort.——A house of ten stories, besides cellars, is being erected in a suburb of Paris. It has no staircase, but every minute a hydraulic lift is intended to convey persons, or things, from below to either of the rooms above, or descend by the same means.

Railway Iron.—The quantity of railway iron exported in the first seven months of this year was 312,732 tons, and in the corresponding months of 1865 the export was 224,102 tons, and in 1864 the weight was 256,536 tons. Much of the iron was sent this year to the United States. They took no less than 90,979 tons, against 23,825 tons in the corresponding period of 1865. British India has taken 73,381 tons this year, against 60,638 tons last year, and 31,626 tons in the corresponding period of 1864. Russia took 38,261 tons to July last, and 20,153 in the corresponding period of the last year; and in the first seven months of 1864, 14,490 tons. The value of railway iron exported to the 31st July was £2,539,483; and last year to the same date, £1,828,175, and £2,030,819 in the corresponding period of 1864.

A New Coal Field.—The Lilleshall Company—near Wellington, in Shropshire,—have been these four years sinking a shaft, and reached coal at a depth of 207yds. The vein is horizontal and 6ft. 3in. thick. There is every reason to expect other veins near at hand on sinking. This will add greatly to the area of the Shropshire field. This pit has been about four years in hand, and cost from £30 to £40 a yard. The blue and white flat ironstones are expected on sinking, also the flint coal and other minerals of great value.

The Engineer Surveyorship of the Ports in the Bristol Channel.—We understand that Mr. Casey, chief assistant to Mr. Harrington, of 61, Gracechurch-street, is a candidate for the appointment, under the Board of Trade, of the engineer-surveyorship of all the ports in the Bristol Channel, and that, from his lengthy experience in the nature of the duties involved, there is great probability of Mr. Casey being selected to fill the vacant office.

A Submarine Convulsion has caused the rock La Marola at Coruna to disappear, after being thrown against the rock Los Animas. Between the rocks surrounding the fort St. Antohio a little creek has been formed capable of containing about a dozen small fishing smacks.

A New Gunpowder is announced, invented by M. Adolphus Newmeyer, a German chemist. It claims on attention include non-explosiveness in the open air, carries farther than common gunpowder, is cheaper, and is so easily made that it may be manufactured on board ship. Thus it is expected to explode only when confined, as in the chamber of a mine, or the recess of a gun. Experiments to decide the merits of these claims, are in progress on the site of the Trocadero, opposite the Champs de Mars, at Paris.

NAVAL ENGINEERING.

Engines for the "Monarch."—Messrs. Humphrys and Tennant have received an order from the Admiralty for the construction of the engines, 1,100 horse-power nominal, for the *Monarch* turret ship, building in Chatham dock-yard. This firm put the engines on board the *Pallas* (now with the Channel squadron) which are working satisfactorily.

The "Warrior" is having a scupper-holes cut in her armour-plating for the discharge of water from her decks, and also scuttles for ventilation. This is a heavy job, but it will be highly condncive of bealth to the crew. The iron bulkheads are also being cut, and water-tight doors fitted to perfect the ventilation below.

The "Dunderberg."—This gigaatic iron-clad ram which has been built in the dock, yard of Mr. William Webhe, at New York, was tried Sept. 5th. She is 380ft. long, 72ft. in width in her central part, and of 5,000 tons burthen; she displaces a quantity of water equal to 7,000 tons, and her armour of iron weighs 1,000 tons. This vessel is built upon a model entirely different from that of the Monitors, and of the new ironsides. Her outward appearance resembles more that of the *Merrimac*, the famous Confederate ram. Her battery, which is to be armed with fifteen or sixteen heavy guns, forms under the deck a casemate, with sloping sides, upon which the enemy' missiles, it is supposed, will glance harmlessly off. The height of this casemate is about 8ft. She has gun-ports on every side, which open and shut by the action of a steam engine. But what renders the *Dunderberg* more redoubtable is a great moveable spur of 50ft. long, which forms before the vessel a kind of sword rising above the water 21ft. The speed of the *Dunderberg* is remarkable. During her trial she ran easily nine knots under a small canvas, and it is estimated that if the full power of her screw was put in action she could do from 16 to 18 Her engines are of 6,000 horse-power. During her trial voyage in the bay the *Dunderberg* performed the manœuvre of veering round, in order to fire her broadsides successively. The ram went round forty-one times in a space equal to the half of her total length, and each turn lasted about three minutes and a half. So that once in action the *Dunderberg* could successively fire seventeen broadsides in an hour without changing place, and, consequently, without leaving the line of battle which she occupied. Such a result no man-of-war has attained till now. The armament of the ram will not be sent on board immediately, as the government has the intention to class her among the reserve. She will be sent, without doubt, to League Island, near Philadelphia, where the Monitors are kept. According to a despatch, received through the Atlantic cable, it appears that the Prussian government has an intentiou of buying this ship, but there is no reason to believe that she is for sale.

Defective Anchors.—The Bureau Veritas in France has addressed the following communication to the Seaports:—"The English law forbids the employment of anchors and chains that have not been tested under the superintendence of Government agents. The result is, that many anchors and chairs that have not properly supported the test, are sent to the ports of the continent. In consequence, the administration of the Veritas gave notice that from the 1st of January next, anchors and chains of English make must be accompanied by a certificate, that they have been tested before they can be accepted by experts. In the absence of such a document, experts must require that tests be made in their presence."

Capstan Pumps.—A very successful trial was made on the 5th October on board the *Mersey* screw-frigate, at Portsmouth, of Bank's patent capstan pumps. The pumps are worked on the upper deck of the ship by a messenger chain from the capstan, running over the pitch-wheel of the pump. The advantage of this arrangement over the old plan is that it enables the crew, in the event of the ship being on fire below, to continue working the pumps without being driven away by the smoke when working them below and between decks, as was the case with the crew of Her Majesty's late ship Bombay, on the loss of that vessel by fire off Buenos Ayres.

STEAM SHIPPING.

Twin Screw Turret Ships.—Messrs. Laird Brothers, of Birkenhead, have just launched a vessel which is stated to be the largest twin screw ironclad yet built. She is called the *Prins Hendrik*, and has been built for the Dutch Government. The *Prins Hendrik* is a vessel of 2,100 tons and 400-horse power, with a speed of more than 12 knots an hour, on a draught of water of 18ft., throwing a broadside of 1,200lb. from her two turrets. The dimensions are about 240ft. extreme length, 44ft. breadth, 28ft. deep, and 2,100 tons measurement. The hull is built of iron, of great strength, and is divided internally by bulkheads into watertight compartments, so as to enclose her turrets, magazines, engines, and boilers in separate appartments. In addition to this provision for the ship's security there is a double bottom under the engines, boilers, turrets, and magazines extending up to the lower deck. The armour-plating is $4\frac{1}{2}$in. thick, and rests on a teak backing 10in. thick. There is free communication from one end of the ship to the other by iron sliding doors on all the watertight bulkheads, and the spaces in the storeroom and magazines are ample enough for the stowage of six months' provisions. The turrets are cylindrical in shape, covered with armour-plates $5\frac{1}{2}$in. thick, and are placed one before and the other abaft the engineroom, and are fitted with slides and carriages for two $12\frac{1}{2}$-ton 300-pounder guns on the system of Captain Cowper P. Coles, R.N. The rig is that of a bark, the fore and main masts being fitted as tripods on Captain Coles's patent, to give greater range of training to the guns in the turrets. There are two separate pairs of engines, each of 200-horse power nominal, having cylinders 56in. diameter, and 2ft. 3in. stroke, driving two screw propellers each 15ft diameter.

The French Government has commuuicated the following letter to the *Moniteur*:—"Hakodadi, Japan.—We recently witnessed the arrival in this port, from Nagasaki, of the first steamer employed by a native in commercial operations. This vessel is of English build, and is named *Kin-sin*. She was brought by the Prince Satsuma from Messrs. Fletcher, English merchants established in China. After having stopped some days at Hakodadi, she has left with a full cargo for Yokohama. This fact, though simple id appearanee, is worthy of remark. It testifies to the readiness of the Japanese to confide their merchandise to vessels of foreign build, the incontestable superiority of which over the fragile junks they have heretofore used is evident. It is not doubtful that the opening of new ports will permit foreign commerce not only to develop its distant operotions, but to gain profit by carrying from port to port along the coasts, in European vessels, Japanese productions destined for native consumption. The profit would be great even if the Japanese should prefer to have these coasting operations done under their own flag, as they would have to buy vessels built abroad, together with engines, and materials for rigging, all in considerable quantities. They would, besides, be induced to work their coal pits, and to employ the improved system of modern industry in so doing. Commerce in the extreme East would gain an immense advantage in procuring coal in Japan at a modern price."

LAUNCHES.

The Launch of the "Pirapama."—On October 7th the iron paddle steamer *Pirapama* was launched from the yard of the Preston Iron Ship Building Company, Preston. Her length on water line is 190ft., beam 25ft., depth of hold 11ft. tonnage, B.M. 722, A.B. at Lloyds. Full poop for fifty first class passengers. The engines were supplied by Messrs. James Watt and Co., they are of 120 horses power nominal (oscillators) fitted with surface condenser, superheater, feathering floats, &c. The above vessel is sister ship to the *Tpojuca*, which was launched by the above company about two months ago.

The great transport-ship *Jumna*, built by Messrs. Palmer, at Jarrow-on-the-Tyne made a beautiful launch on September 24th, at 4.5 p.m., and was towed and moored safely in the Tyne Dock. The *Jumna's* length is 360ft. between perpendiculars; extreme, 370ft. $5\frac{1}{2}$in.; 49ft. beam; depth moulded, 41ft. 11in.; registered tonnage, 4·173 25·94, by displacement upwards of 6,000 tons. Her engines will be of 700 horse-power, nominal. The hull is divided into 26 compartments, each one is water-tight, so that should any accident occur to one portion of the vessel no risk will be incurred to the whole. The whole of the interior of the ship, save those portions necessarily set apart for machinery and the working tackle, has been designed and arranged for the accommodation of army

officers, troops, passengers, seamen, &c. Each suite of compartments is separate and independent of the other, yet each is comprehended in one plan of ventilation, so from one end of the huge ship to the other, and from the lower deck to the poop, a constant supply of fresh fresh air is obtained to provide sleeping accommodation for the troops and seamen. The roofs of the various decks are so arranged that hammocks can be slung from them. The poop and forecastle will be connected by three bridges, one on each side of the vessel, and the usual bridge above the centre of the upper deck. The steering apparatus and capstans will be of a very strong and complete description. The launch of this noble vessel, notwithstanding the unfavourable state of the weather, was witnessed by a great concourse of spectators.

TELEGRAPHIC ENGINEERING.

Telegraphy.—Now that success has crowded the efforts to extent the immense benefits of telegraphy, we see "notes" of all kinds, and each giving or claiming credit for somebody. How long may we ask did Cook and Wheatstone have their wires between Slough and Paddington, before they were esteemed worthy of more than the ridicule of the passer by. It must be again recorded, that it was left for crime of the deepest dye to stamp the electric telegraph with all the commercial value it possesses. Men, in the aggregate, looked at it with a sneer, as at a toy beneath their notice, until it eked out the murderer's name in anticipation of the train by which he travelled. But for that event Wheatstone might have struggled on into poverty, like many others. This state of things continue to this day, but such difficulties will vanish as education advances. There is but poor sympathy existing between the thinker and the world in general.

RAILWAYS.

Royal Commission on Railways.—The Commissioners have completed their task of taking evidence, and are engaged in preparing their report which will be submitted to parliament when it meets. This report is most anxiously looked for by the profession.

South Eastern.—Mr. Cudworth has designed several new tank-engines for the Charing Cross and Greenwich lines. They have eight wheels, with a four-wheeled bogie constructed on Adams' patent, placed under the trailing end. The four leading wheels are 5ft. 7in. in diameter and coupled. The cylinders, which are inside, are 15in. diameter with a stroke of 20in. This disposition of the bogie affords a long foot plate and consequently good accommodation for the men.

The East London which will extend from Broad-street *viâ* the Thames Tunnel, to the East Kent line at New Cross, is steadily progressing in various parts of the intended line. Most of the preliminaries, such as borings, retaining walls, &c. are in a forward state. Plant and material are being collected, ready for a vigorous prosecution of this important line.

Neath and Brecon.—The new line from Neath to Brecon was opened on the 18th ult. Its total length is about 33½ miles. This line opens up a desirable communication with valuable mineral properties, which have hitherto been only partially developed, owing to the expense of transit to the coast. It will become a through route from South Wales to Liverpool, Manchester, &c. A branch will connect this railway with the Central Wales system, and thus open a direct route to the North of England, at a saving of about 30 miles. We learn that the gradients of the Neath and Brecon line are rather heavy in some parts.

Metropolitan Railway.—The increasing traffic in the Metropolitan has compelled the widening of the line. A further increase is expected on the completion of the Midland Counties line, which is in rapid progress of execution.

DOCKS, HARBOURS, BRIDGES.

The New West Dock at Hull.—The works on this capacious dock have been impeded by the bursting of the embankment which is between it and the river, and to which it is parallel. The tides had been unusually high, and on the 17th ult., they accumulated sufficient pressure to force in about 150yds. of the embankment, and some of the new river wall.

Proposed Canal across the Isthmus of Panama.—In the United States of Columbia a bill has been passed, authorising the Government to cede to a company, or private individual, the right of cutting a canal through the territory of the Republic from the Atlantic to the Pacific. The privilege is to be for 89 years, and the canal is to be executed in ten years from the date of the concession. The concessionnaire is to pay the Government 6 per cent. of the clear profits during the first twenty-five years, and 8 per cent. during the remaining 64. No subvention is promised. The line to be taken by the canal is left entirely to the choice of the concessionnaire, The Consul-General of Columbia at London has been authorised by his Government to give all further information on the subject that may be required.

MINES, METALLURGY, &c.

California continues to be celebrated for many things. The *Nevada Gazette* adds another claim as follows:—A tunnel was run into the Mansanita Hill, 90ft., and a cross-cut of 60ft. was run at the end. This cut was closely packed with 510 kegs of powder, each keg having its head taken out. The tunnel was then closely tamped. The entire hill, 150ft. in depth, 200 in width and almost 300ft. back from the front, was lifted several feet in the air and completely broken up ready for hydraulicing. The cost of running the tunnel, powder, &c. was about 3,000 dolls.

The Mining and Scientific Press of San Francisco gives an of a new account rock drilling machine. A new power drill has lately been put in operation in a tunnel which is being driven for Massachusetts Western Railroad, through the Hoosac Mountain. It appears that with a horizontal machine, at 30 pounds pressure, a hole 1¾in. in diameter was drilled 15½in. in 7½ minutes; on the vertical machine, 15¾in. in 7½ minutes; on the horizontal again, 29½in. in 12 minutes. The rock was granite taken from Rollstone Hill in Finchburg; the drill striking 200 times in a minute, and advancing one inch every eighteen strokes. The bottom of the drill is nearly in form of a letter X.

Improvement.—The proprietors of the Baker and Crosby mine are about putting up a dozen of Baux and Guiod's pans. By the process they have heretofore used, they obtained only six or seven dollars per ton of ore, whilst with one of these pans they get 36 dollars worth of gold from the same rock.—*The Mining and Scientific Press.*

The Americans are introducing steam stamps on the same principle as our steam hammers. The *American Artizan* says that each cylinder is 5¼in. diameter and 6 to 8in. stroke. Each machine does as much work as 30 stamps worked in the ordinary way. It is capable of crushing 30 tons of the hardest kind of ore in twenty-four hours. Of course they are careful to provide for the wearing of the stamp-heads, and the clearance between piston and top and bottom of cylinder.

Revenue of the Clyde Trust.—The revenue for the past year was £125,782 15s. and of the preceding year £121,587 being an increase of £4,205. But for the falling off in the sum received from the Cumbrae Light Trustees, the increase would have been £6,900.

Rating of Collieries.—Mr. Coulson's principles.

Annual value.	Rateable value.
Coal.—The actual rent that coal is now let at per ton, 36s. for coking coal and 26s. for household coal.	No deductions for repairs.
Plant.—The annual value or rent a tenant would give for it, for the purpose of working the mine.	25 per cent. deduction for repairs, &c.

Messrs. Taylor and Hedley's principle.

Coal.—Rent from 19s. to 20s. per ton.	A deduction of 25 per cent. from the rent to recoup the corpus and for repairs.
Plant.—6 per cent. on the structural value.	25 per cent. deduction for repairs.

Furnace Coke.—Experiments have for some time past been conducted by Mr. Playton at Penistone, to discover the means of making the best coke for iron smelting. The result is that a mixture of equal quantities of Barnsley steam coal, and ordinary "smudge" produces a coke that is almost unequalled for the use of furnaces.

Iron, Improved Make.—Two one-inch bars made at the Lonsdale Hematite rolling mills were tried recently at Liverpool. They broke at 18 tons 15 cwt., or 6 tons 10 cwt. more than the stipulated strength.

Reported Discovery of Coal in South Australia.—Mr. J. Hodgkiss, acting for himself and others, lodged a claim with the government at Adelaide, on the 16th of August, for the reward of £5,000 offered some three years ago to any one finding a payable coal mine in South Australia. It is said such a discovery has been made at Port Lincoln, and Mr. Hodgkiss has secured three sections of land, within a mile of the coast, at Port Lincoln proper, on which the discovery is said to have been made. The *Lubra* brought specimens of the coal to Adelaide, which are in the possession of Mr. Hodgkiss. Some of the specimens have been submitted to certain tests by Mr. Heuzenroeder, the chemist, with very unsatisfactory results. It is said to be certainly not coal, but a sort of bituminous substance, which may or may not indicate the neighbourhood of coal. The specimens sent from Port Lincoln have since been submitted to competent inspection, and the gentlemen who have analysed them have pronounced them anthracite. If this be correct, then the discovery will be a valuable one.

GAS SUPPLY.

Prevention of Offensive Smell.—The offensiveness of gas works is well known to be mainly due to the escape of those gases which are retained by the purifiers until they are opened to remove their unpurified contents. The engineer of the Manhattan Gas Company successfully overcame this difficulty by forcing air through these purifiers, after the flow of gas had been directed into another set of purifiers. The air escaped through iron pipes into a tall chimney, earrring with it the offensive gases complained of. The lime remained in the purifiers as before, to do duty a second time, or until neutralised; repeating the forcing of the air at diminished intervals of time.

APPLIED CHEMISTRY.

Cement for Rooms.—An invention by M. Sarel, of Paris, is stated to be superior to plaster of Paris for coating the walls of rooms. It is used as follows:—A coat of oxide of zinc, mixed with size, made up like a wash, is first laid on the wall, ceiling, or wainscot, and over that a coat of chloride of zinc applied, being prepared in the same way as the first wash. The oxide and chloride effect an immediate combination, and form a kind of cement, smooth and polished as glass, and possessing the advantages of oil paint without its disadvantages of smell.

Engineering in Spain.—A correspondent of the *Times* writes from Cartagena, Sept 28:—I had this day an opportunity of witnessing the trial of the large iron floating dock which had been sent out here in pieces from England some four years past, and only recently completed here. A short time ago a man-of-war, the *Alceda*, of some size, had been lifted high and dry out of the water for the purpose of undergoing repairs, and as it was the intention to replace her in the water again this day, I proceeded on board about nine o'clock for the purpose of seeing it. At twenty minutes past nine orders were given to sink the dock and allow the vessel to float out. The engineer in charge, Mr. Fenwick, an Englishman, who was the superintendent of the work here, immediately gave orders to open the valves, when the dock began to sink gradually, retaining its horizontal position. At twenty minutes to ten the water began running over at both ends. The dock, having sunk some 5ft. or 6ft. in a few minutes, the two streams met in the centre, showing how equally the dock had sunk, the entire floor being now covered with water and touching the keel of the vessel, and half-an-hour afterwards the vessel was afloat. The valves for immersion were now closed and the vessel hauled out. This operation of sinking the dock was effected with such steadiness and regularity that unless the height of the water was carefully observed no motion was apparent. Mr. G. B. Rennie, the patentee of the dock, and his wife, who had just come out from England, were on board. By an arrangement of air or buoyant chambers, the dock cannot sink beyond a certain depth. In order to demonstrate this (after the vessel was clear of the dock), Mr. Rennie requested that the immersion valves might again be opened and the dock allowed to sink to its greatest depth; in a quarter of an hour this was done, and she would sink no deeper, leaving the sides about 8ft. out of water. This will allow of a vessel drawing 27ft. of water being docked. The engines for pumping out the water from the dock were now set to work, and in four hours she was raised up again. As the question of dock accommodation is now of some interest to the British public, a slight description of the famous port of Cartagena and its docks might be acceptable. The "darsena," or dockyard, is situated within a fine large sheltered harbour, and is the naval port of Spain in the Mediterranean. The "darsena" consists of a large artificial basin some 1,800ft. long, by 1,100ft. broad, and is in some places as deep as 48ft. Surrounding the quays are the different storehouses and dry docks, which were made about the same time as the basin, now nearly eighty years ago, but it is still larger than the basins of Plymouth, Portsmouth, and Chatham, or even those new basins recently made at Cherbourg. The dry docks above mentioned are only suited to the size of vessels made in the last century. The insufficiency of dock accommodation for large vessels of the present period at last induced the Spanish Government to improve it, and Messrs. Rennie, of London, were requested in 1859 to furnish designs for the iron floating dock, which eventually they carried out, though now, from the length of time of putting it together in this country, some of the novelty of floating docks has been lost. It is due to the Spanish Government and General Quesada (Chief of Engineer Corps) to say that they were the first who undertook its adoption, and it is still, I believe, the only example of the kind in actual use with success. The length of the dock is 325ft.; the breadth, 105ft.; the lifting power, independent of the weight of the dock, is about 6,500 tons dead weight. The dock has now been completed and afloat for four months, during which time four vessels have been docked with perfect success, and it is due to the engineer in charge to say that when it was first floated it was found to be perfectly watertight, and the first trial of sinking was made with as great facility and regularity as that of the *Alceda* this day. It is currently reported that, as soon as some of the Pacific fleet arrive, one of the large iron-clad vessels will be lifted. The weather is still hot here, the thermometer standing at 74 in the shade, but last night there was a heavy shower, the first for the last nine months.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF THE ARTIZAN."

DATED SEPTEMBER 18th, 1866.

2391 W. H. Bailey — Combined bath, travelling trunk, and self rocking cradle
2392 J. Thompson—Machinery for turning or cutting and polishing screw nuts and other articles
2393 W. R. Lake — Projectiles for firearms and ordnance
2394 W. E. Gedge—Machinery for separating grain from straw
2395 T. Parkes—Tube cotters
2396 H. J. Newcombe — Heating and warming buildings
2397 J. H. Sams—Straining or tightening wire
2398 H. W. Ley—Working cords, straps, or chains with pulleys
2399 A. S. Stocker — Improvements appertaining to bottles
2400 A. R. Stark—Manufacture of gas
2401 F. Sage—Show cases or boxes

DATED SEPTEMBER 19th, 1866.

2402 G. Keene—Sausage making and mincing machine
2403 H. S. Cropper—Printing machines
2404 W. Dennis—Construction of letter boxes and letter pillars
2405 E. Barlow and W. N. Dack—Steam engines
2406 E. Barlow and W. N. Dack—Machinery for planing metals
2407 W. E. Gedge — Pneumatic steam dredging machine
2408 T. Dixon—Arrangement of steam boiler and furnace
2409 J. P. Robinson — Jackets, capes, and other like garments for ladies

DATED SEPTEMBER 20th, 1866.

2410 G. Ashworth and E. Ashworth—Portfolios or cases for holding musical publications, &c.
2411 F. Sutherland—Improvements in umbrellas
2412 C. H. Chadburn—Moveable door screens
2413 C. W. Siemens—Smelting metallic ores and furnaces to be employed for that purpose
2414 G. J. Walker—Carriage break applicable to common roads
2415 A. B. Pérard—Manufacture of steel and apparatus employed therefor
2416 A. B. Walker—Brewing, malting, distilling, and apparatus employed therein
2417 H. Carter and G. H. Edwards—Breech loading firearms
2418 C. Crump — Solvents for resins and resinous substances, caoutchouc, gutta-percha, oils, and fats

DATED SEPTEMBER 21st, 1866.

2419 G. O. Goolay — Manufacture of thatch, and machines for producing the same
2420 J. W. Morgan—Ships' anchors
2421 J. Marsh — Method of lubricating vertical spindles or shafts, and apparatus for effecting the same
2422 G. Davies—Fabric to be used for the manufacture of driving belts, hose, and for other useful purposes
2423 G. A. Laurent—Preventing accidents on railways
2424 G. Smart—Breech-loading guns
2425 W. Clark—Machine for setting and distributing types
2426 W. Clark—Securing teeth in saws
2427 W. Clark—Picker motions for looms
2428 R. Richardson—Water supply
2429 T. Challinor—Machinery for polishing boots and shoes, harness, and other manufactured leather goods
2430 A. V. Newton—Construction of weight
2431 J. Clark—Wire bands and combs or heckles used in the preparation of cotton wool and other fibrous substances
2432 T. A. Rochussen—Constructing the permanent ways of railways
2433 G. Dyson—Drying and ventilating corn and other agricultural produce, and in apparatus therefor
2434 J. M. Heppel—Fluid meters

DATED SEPTEMBER 22nd, 1866.

2435 S. R. Freeman and A. Grundy —Breaks for retarding machinery and vehicles used on rail or common roads
2436 I. Dimock - Brushes and their manufacture
2437 G. Tbring — Construction of stiles used in public and private pathways
2438 D. J. Fleetwood — Manufacture of dies or moulds used for stamping, pressing, or moulding metal, glass, or other material capable of being so treated
2439 J. G. C. Fussell and W. Wise—Construction of scythes
2440 T. Atkinson — Machine for wringing and mangling
2441 T. Brace and W. Savory—Self-acting feeding apparatus for cotton gins
2442 F. R. Mosley—Lamps for burning paraffin oil and other volatile liquid hydrocarbons
2443 J. R. Johnson and F. Gale—Waterproofing leather, canvas, and other fabrics
2444 J. C. Ramsden—Reeds or combs for weaving or other purposes
2445 A. C. Wansbrough—Manufacture of paper
2446 W. Weichert—Construction and arrangement of chronometers, barometers, and thermometers

DATED SEPTEMBER 24th, 1866.

2447 I. Herrmann — Chronometers, or other time keepers
2448 T. Whitaker and J. Constantine—Construction of stoves or other heating apparatus for warming and ventilating public and private buildings, baths, hothouses, and drying houses
2449 A. F. Stoddard—Artificial coal or fuel
2450 A. F. Stoddard—Improved fuel
2451 W. E. Newton—Machinery for filtering liquids
2452 J. Calvert—Treatment and manufacture of iron and steel
2453 R. Kunstmann—Drying solid substances and apparatus employed therein
2454 J. Gamgee and A. Gamgee—Slaughtering of animals with a view to the preservation of their bodies as articles of food, and the method of preserving animal and vegetable substances
2455 G. Adams— Machine for printing dates on railway tickets, and for other like porposes
2456 A. V. Newton—Steering vessels

DATED SEPTEMBER 25th, 1866.

2457 J. Chaddler—Drawing and preventing waste of water from service pipes or cisterns
2458 H. Turner—Consuming smoke and economising fuel
2459 W. Hunter—Machinery for untwisting, separating, and combing tarred ropes for oakum and for dressing hemp, flax, manilla jute, or other like materials
2460 W. C. Finnack—Means and apparatus for effecting the revivification of animal charcoal
2461 C. E. Brooman—Lace machinery
2462 J. Lawson and E. G. Fitton—Machinery for preparing and spinning flax, tow, jute, and other fibrous materials
2463 J. Barker—Apparatus employed in printing and folding paper hangings and woven fabrics
2464 J. Duckett—Manufacture of scouring stones
2465 A. Steven—Elevating or conveying yarns or similar materials
2466 A. V. Newton—Steam pumps
2467 W. Neill and P. Smith — Manufacture of chloride of lime or bleaching powder
2468 W. E. Newton—Cornets and other similar musical instruments
2469 W. R. Lake—Steam engines
2470 G. E. Von Derburgh—Composition and production of artificial stone cement, &c.
2471 H. Starr—Lamps for and in the mode of burning volatile oils, spirits, and other fluids
2472 J. J. Lundy—Treatment of the residues resulting from and obtained in the purification and distillation of mineral oils, for the purpose of utilising the same
2473 J. Hamilton—Fuel for heating purposes
2474 T. B. Taylor—Pumps for ships
2475 A. H. Thorgar—Manufacture of overshoes
2476 H. Aydon and G. B. Jerram—Furnaces and the method and apparatus for supplying such furnaces with fuel or other combustible matters

DATED SEPTEMBER 26th, 1866.

2477 W. E. Gedge—Looms for weaving gauzes and other fancy goods
2478 T. Amey—Process for preserving milk, and apparatus connected therewith
2479 J. C. Sellars—Improved metal founders' blacking, and mode of treating and preparing the same
2480 H. A. Bonneville— Transmitting facsimiles of writings and drawings by means of electric currents
2481 H. A. Bonneville—Machinery for carding wool and other fibrous materials
2482 H. A. Bonneville—Machinery for weaving wool and other fibrous materials
2483 H. A. Bonneville—Raising water
2484 G. Haseltine—Bronzing machine
2485 J. H. Johnson—Taps or cocks for water and other fluids
2486 J. Y. Betts—Mode of drying corn and other agricultural produce in the straw
2487 J. T. Wood—Means of compressing and packing cotton, wool, jute, and other similar bulky articles
2488 G. H. Brockbank—Manufacture of pianofortes
2489 M. P. W. Boulton — Employing the motive power of jets of fluid
2490 A. F. Johnson and M. P. Griffin—Cutting of files or the formation of making their teeth
2491 W. Clark—Collection and delivery of letters

DATED SEPTEMBER 27th, 1866

2492 W. R. Corson—Affixing knobs or handles to the spindles of door furniture
2493 T. Lythgoe—Improvements in water closets
2494 J. Burgum — Puddling and heating furnaces and other furnaces used in the manufacture of iron and steel
2495 J. C. Bayley and D. Campbell—Sheathing of iron ships
2496 A. V. Newton—Distilling petroleum and other oils
2497 H. E. Gilles—Processes for producing fibres suitable for being spun from rags or remnants of woven or other textile fabrics made of silk, wool, cotton or other fibrous materials
2498 J. E. Thibault—Means for preventing ships or vessels from foundering by imparting additional buoyancy thereto
2499 T. W. Bunning — Drifting and riveting machines
2500 G. Slater—Churns
2501 J. A. Chanfourier—Self-feeding cotton gin
2502 J. H. Dallmeyer—Compound lenses suitable for photographic uses
2503 E. B. Bigelow—Power looms
2504 F. W. C. Dromtra—Securing pocket books and other portable articles on the person

DATED SEPTEMBER 28th, 1866.

2505 M. Ridley, W. Pawson, and C. Basker—Raising and stacking straw and other agricultural produce
2506 J. Broughton—Washing machine
2507 W. Ryan and W. Egar—Fire escape
2508 J. S. Johnstone—Producing motive power and machinery employed therefor
2509 J. H. Johnson—Railway switches
2510 C. Fox—Safety belt for use in travelling to prevent injuries from concussions or otherwise
2511 S. Price—Lifting or assisting to lift, and securing window sashes, shutters, and other like frames and weights
2512 W. Wood and J. W. Wood—Manufacture of lozenges, &c.
2513 W. Clark—Means of reproducing signs, characters, and other marks in the transmission of messages and signals by electric telegraph apparatus
2514 W. Clark—Electric telegraphs

DATED SEPTEMBER 29th, 1866.

2515 D. Joy—Steam engines
2516 D. Imhof—Machinery of chimes
2517 H. A. Bonneville — Fitting garments called Conformators
2518 J. Goeunier-Lauriac—Process of casting iron cylinders, or any other cast iron pieces with hard metallic thickness or wrapper, and separately with white and grey iron, so that both kinds of casting are sticking together
2519 P. P. J. Martin—Cotton seed hullers or decorticating machines
2520 W. La Pénotiere—Firearms
2521 W. Clark—Steering vessels
2522 J. Whitworth — Casting iron and steel, and apparatus employed for this purpose
2523 R. Hornsby and J. E. Phillips—Reaping and mowing machines

DATED OCTOBER 1st, 1866.

2524 J. Chalmers—Bolts and washers
2525 P. R. Hodge—Filtration of fluids
2526 A. M. Dix—Refrigerators
2527 W. Clark—Furnaces for treating metals and other matters
2528 P. A. Batchelor—Construction and arrangement of retorts and settings in combination with machinery for the manufacture of coal or other gases

DATED OCTOBER 2nd, 1866.

2529 W. Redman—Machinery for spinning cotton, silk, and other fibrous materials
2530 T. Berney—Projectiles and ordnance
2531 F. Tolhausen—Manometrical sounding apparatus

DATED OCTOBER 3rd, 1866.

2532 J. Cavanah—Water-closets, cisterns, and soil traps
2533 J. Oetzmann—Construction of mattresses
2534 D. Barker—Artificial fuel
2535 M. P. Robertson—A certain tie to be called Wailey's self-fastening iron tie
2536 C. E. Brooman—Production and application of an imponderable fluid, together with the means employed therein
2537 M. West—Fish-tail gas burners
2538 J. Daniel—Hydraulic dresses
2539 J. R. Swann—Safety valves
2540 W. Hope and H. Browning—Composition to be substituted for ordinary paints
2541 T. Forster — Elastic mats and coverings for floors
2542 C. E. Spagnoletti—Arranging and combining apparatus for communicating between the guard, engine driver, and passengers in a railway train
2543 E. P. Lane—Lane's reaping machines now in use
2544 T. Wilson—Breech-loading firearms
2545 R. Mortimer—Instruments for marking or impressing railway tickets, and for other like purposes
2546 H. Fisher—Boilers and boiler furnaces
2547 W. D. Scott—Raising vessels, and machinery employed therefor
2548 W. R. Lake—Cutting files and rasps
2549 W. R. Lake—File cutting machinery
2550 J. H. Wrench—Representation of opaque objects tonn enlarged scale

DATED OCTOBER 4th, 1866.

2551 J. W. Daniell—Construction and mode of propulsion of locomotive carriages, and apparatus to be used in connection therewith
2552 J. Wolstenholme and T. Pendlebury — Tube and bar cutters, and apparatus connected therewith
2553 E. Casper—Extinguishing fires
2554 G. E. Searle—Ear-rings
2555 G. P. Dodge — Folding and shaping belts or bands of indiarubber and woven fabric
2556 J. A. Coffey—Mechanical contrivances applicable to syphons
2557 G. E. Donistborp—Washing wool, hair, and other fibre
2558 D. H. Saul and H. P. Armstrong—Carburetting gas
2559 J. H. Johnson—Grate bars
2560 G. Underwood—Boiling, steaming, and cooking apparatus
2561 W. E. Newton—Forming collars on metallic axles and other articles
2562 J. Ferrabee—Preparing wool and other fibrous substances
2563 F. W. Kaselowsky—Carding the tow of flax, &c., and separating the woody particles therefrom
2564 F. W. Kaselowsky — Separating the woody part from the fibre of flax, hemp, or other fibrous substances of the same nature

DATED OCTOBER 5th, 1866.

2565 D. C. Pierce—Improvements in anchors
2566 J. C. Chapman—Steam engines
2567 F. H. Schroder—Incubators for hatching eggs
2568 W. G. Valentin and G. H. Benson—Manufacture of steel
2569 J. Badcock — Manufacture of ornaments for the wrist

DATED OCTOBER 6th, 1866.

2570 H. Garside—Marking, etching, or engraving on cylindrical and other surfaces
2571 G. Gordon—Treating animal charcoal used in the preparation of sugar, and apparatus employed in such process
2572 W. Dennis—Construction of bottles
2573 W. E. Hickling — Washing bottles and unstoppering the same
2574 S. Deacon—Construction of certain parts of oscillating steam engines
2575 E. Lichtenstadt—Lamps for burning volatile oils or spirits, and preparation of the materials for burning in such lamps
2576 J. Burgess — Crochet needles and handles of crochet needles
2577 S. Leather—Articles of dress
2578 W. Clark — Hoisting apparatus and cars for mining purposes
2579 W. Clark—Fastenings for purses, &c.
2580 J. von der Poppenborg—Breech loading firearms, and cartridges for the same

DATED OCTOBER 8th, 1866.

2581 A. Ripley—Water meters
2582 J. H. Roberts— Fastening for windows and other places
2583 W. E. Gedge—Tilt hammer
2584 M. Starr—Caps and other coverings for the head for naval, military, and general use
2585 G. Haseltine—Leather binding
2586 J. Robertson—Fire places, and fire bars to be used therein
2587 J. H. Johnson — Treating stale bread and biscuits
2588 B. C. Newell—Pianofortes
2589 W. Clark—Central fire percussion cartridges
2590 W. E. Newton—Atmospheric engines
2591 W. E. Newton—Steam engines
2592 G. Betjemann, G. W. Betjemann, and J. Betjemann — Articles commonly called writing or library sets, &c.
2593 G. T. Bousfield—Separating sulphur from soda waste
2594 G. T. Bousfield—Brick making machines

DATED OCTOBER 9th, 1866.

2595 J. Greening—Folding fencing
2596 J. W. Baker—Spinning cotton, &c.
2597 J. Monnin, C. Bosc, and C. A. Boissenot—Carriage indicators
2598 H. Forbes—Raising and propelling of water and other fluids
2599 W. E. Gedge—A funnel
2600 W. E. Gedge—Cutting out of boots, &c.
2601 M. Mirfield and J. Scott—Combing wool, &c.
2602 E. T. Hughes—Filtering presses
2603 J. Conlough—Preparing fibrous materials to be spun
2604 C. Perry—Flattening hackle pins
2605 T. Vicars, T. Vicars, and J. Smith—Furnace grates on which the fuel is made to travel
2606 G. W. Shinner—Utilising sewage matters and liquids
2607 T. Ootram—Cast iron
2608 W. Dudgeon—Constructing vessels propelled by twin twin propellers, and steam engines to give motion to the same
2609 C. J. Hills—Reduced copies of medallions and matrices, and cutting tools for the same
2610 G. F. Bradbury—Sewing machines
2611 C. A. McCurd—Sewing machines
2612 G. H. Benson and W. G. Valentin—Melting and casting of steel and the means employed
2613 G. Pitt—Uniting parts of metal bedsteads, &c.
2614 G. H. Benson and W. G. Valentin—Malleable iron and steel, and the means employed
2615 E. Peyton—Printing cylinders
2616 G. H. Benson and W. G. Valentin—Iron and steel, and the means employed

DATED OCTOBER 10th, 1866.

2617 J. Warwick—Sewing machines
2618 L. Wilson—Heating baths, and means employed in the same
2619 M. Myers—Making of trunks, &c.
2620 J. Bollough—Looms for weaving
2621 W. Maulby—Means to prevent injury to people in railway trains
2622 J. Syme—Breech loading firearms
2623 A. H. Brandon—Electrical apparatus

DATED OCTOBER 11th, 1866.

2624 W. Pidding—Treating threads, &c.
2625 E. B. Wilson—Furnaces
2626 R. E. Lazenby—Opening and cleaning wool, &c.
2627 G. Hadfield—Furnaces and copulas
2628 D. Crichton, W. Douhavoud, and D. Crighton —Looms for weaving
2629 D. Rowe—A toy
2630 A. V. Newton—Sewing machines
2631 R. H. Bollans — Administering vapour baths and fomentations
2632 W. Watson—Provision safes
2633 H. Messer—Heated air engines
2634 I. M. Evans—Preventing explosions in steam boilers
2635 H. Jones—A portable bath

DATED OCTOBER 12th, 1866.

2636 H. J. Cooke—Bolt and rivet and nut making machine
2637 J. M. Bancroft— Receptacles for containing tobacco
2638 D. Evans—Papering needles, and envelopes for the same
2639 E. C. Dawson—Cases to hold preserved meats and other substances
2640 E. T. Hughes—Spinning the silk from the cocoons of silkworms, and the machinery employed
2641 W. Gruene—A cigar pipe
2642 A. Wyley — Breech-loading firearms and bayonets

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ON VAST SINKINGS OF LAND ON THE NORTHERLY AND WESTERLY COASTS OF FRANCE, WITHIN THE HISTORICAL PERIOD.

By R. A. Peacock, Jersey.

(*Continued from page* 245.)

CHAPTER VI.—*continued.*

Note.—In the following statement Ptolemy's longitudes and latitudes in degrees and minutes, are given on the left hand, and their respective equivalents in degrees, minutes, and decimals of a minute, are given opposite on the right hand.

114. (From Bertius's Ptolemy, 1618).

"Antœuestœum promontory, which is also called Bolerium.

Long. 11° 30′ .... 5° 28·46′
Lat. 52° 30″ .... 50° 48·68′

[In Mr. Keith Jonhson's atlas the Land's End is given as 5° 47′ W., and 50° 4′ N. Ptolemy's position falls far out in the Bristol Channel, and about 51 miles a little to the east of north of the present Land's End. If the Lionesse country really existed in Ptolemy's time, it cannot have extended as far westward, as is shown in the map in the "Churchman's Magazine,* from Land's End and Lizard Point, *to and comprising the Scilly Isles.* Because Strabo who flourished at least a century before Ptolemy, quoting Posidonius, who was still older, mentions those islands as then existing under the name of Cassiterides,† and that they were ten in number.‡ But it is *possible* that the Lionesse may have extended westwards as far as Seven Stones and northwards as far as Ptolemy's Belerium. Nor will I shrink from expressing an opinion on the following statements gathered from Camden's "Britannia," &c. It is said that in Camden's time the inhabitants of Cornwall were of opinion that the Land's End did once extend further to the west, which the seamen positively conclude from the rubbish they draw up, and that the land there drowned by the incursions of the sea, was called *Lionesse.* That a place within the Seven Stones is called by Cornish people, *Tregva, i.e.* a dwelling, and that windows and other such stuff have been brought up from the bottom there with fish-hooks, for it is the best place for fishing. That at the time of the inundation supposed, Trevelyan swam from thence (which was certainly a very long swim, being at least fifteen nautical miles, if he swam to the nearest part of the main land), and in memory thereof bears Gules, an horse argent issuing out of the sea proper. Dr. Paris in his "Guide to Mount's Bay and the Land's End," p. 91, mentions Camden's tradition of the Lyonesse (the Silurian Lyonois) "said to have contained 140 parish churches, all of which were swept away by the ocean." He says also that the Scilly Isles are now 140 in number, though only six are inhabited. Before the reader and I part company, I expect to have convinced him of *about a score of sinkings of land* having taken place in the localities referred to in these papers, within the historial period. And that consequently, sinking being the rule and not the exception, there is no reason why there may not have been a country called Lionesse, which sank also. It is also possible that there may once have been a dwelling at Seven Stones, and that in the frequent fishings there with the strong hooks and lines used at sea, some relics of such a dwelling may have been brought up. If the Lyonnesse existed it would contain parish churches. That Trevelyan swam fifteen miles on horseback, is of course incredible. Can this be a mistake of Ptolemy or of some of his copyists? Or can there be any truth in Camden's traditionary Lyonesse country? And if so was it on the north of Cornwall, instead of on the west, as generally supposed?

The Damnonium and Ocrinum Promontory.]

Long. 12° 0′ .... 49° 57·28′
Lat. 51° 30′

[The Lizard Point. *Note.*—The modern latitude and longitude were obtained from the Ordnance map. But the latitude has not been used for calculation for reasons previously and hereafter stated. Ptolemy's latitude reduced to modern is given on the right hand. Art. 109, 110.]

But below a large harbour is the island Vectis (Οὐηκτὶς). of which the middle has degrees.

Long. 19° 20′
Lat. 52° 20′

[This occurs at p. 38 of Bertius's "Ptolemy," and no doubt means the Isle of Wight. Art. 109, 110.

In Lib. II., cap. VIII., p. 50, of Bertius's "Ptolemy," we have as follows]:—"The sides of Lyons Gaul, which are near Aquitania are [thus] called. Amongst the rest that which faces the west and is washed by the ocean, is thus described."

The Harbour Brivates.

Long. 17° 40′ .... 2° 11·55′
Lat. 48° 45′ .... 47° 10·91′

[Falls a little south of the present mouth of the Loire, namely, 5½ nautical miles south of St. Nazaire.* It was, doubtless, in this harbour that Cæsar built the fleet with which he afterwards conquered the fleet of the Veneti.]

The mouth of the river Herius.

Long. 17° 0′ .... 2° 32·84′
Lat. 49° 15′ .... 47° 39·95′

[falls 8½ nautical miles *east* of Vannes,* a position which is far inland. Ptolemy's position can hardly be correct, unless the Herius was a tributary of some larger river.]

The harbour Vindana.

Long. 16° 30′ .... 2° 48·81′
Lat. 49° 40′ .... 48° 4·15′

[falls above 30 nautical miles south of the north coast of Britanny, which can hardly be correct.]

The Gobæum promontory.

Long 15° 15′ .... 3° 28·72′
Lat. 49° 49′ .... 47° 39·95′

[as the name of this promontory occurs again (with a different latitude and longitude which nearly coincide with the present position of the north-western angle of Britanny) with the name of the city Vorganium attached; probably the present latitude and longitude which fall about midway between the Ile de Croix and the continent, mean the city, not the promontory.]

But the side which faces the north near the British Ocean, thus has itself,

After the Gobæum promontory.

The harbour Staliocanus. [Falls very near Portrieux.)

Long. 16° 30 .... 2° 48·81′
Lat. 50° 15′ .... 48° 38·02

* July, 1863, p. 39. † Book 3, cap. 2, s. 9. ‡ Book 3, cap. 5, s. 11.

* From Robiquet's Chart "dressée after the Government work, 1858.

The mouths of the river Tetus.

Long. 17° 20′ .... 2° 22·2′
Lat. 50° 40′ .... 48° 2·21′

[the Lyons edition gives the same figures, falls 5 nautical miles north-west of the nearest Minquiers rocks, and more than 30 nautical miles due west of the present west of Normandy. The position ranges well with Great Bank and Rigdon Shoal, formerly forests, a fact very significant. The lower part of the Tetus may have been one of Cæsar's estuaries, to be mentioned hereafter.]

"BIDUCESIUM" [? BIDUCENSES.]

The mouths of the river Argenis.

Long. 18° 0′ .... 2° 0·91′
Lat. 50° 30′ .... 48° 52·54′

falls 17 nautical miles due west of the present coast of Normandy. It was probably the mouth of the river Coülsnom into which the Sée, the Ardée, &c., had previously discharged themselves, as shown on the map. It may also have been one of Cæsars's estuaries.

"VENELORUM." [No doubt the Unelli of Cæsar.]

The harbour of the Crotiatoni.

Long. 18° 50′ .... 1° 34·4′
Lat. 50° 50′ .... 49° 11·89′

[falls 9½ miles north-east of Coutances, and 1¾ miles east of the nearest part of the western coast of Normandy. It may have meant the present Havre de Piron, or the Havre de St. Germain, led up to by one of Cæsar's estuaries.]

The mouths of the river Olina.

Long. 18° 45′ .... 1° 37′
Lat. 51° 0′ .... 49° 21·57′

[falls 6 nautical miles south-east of Barneville, and 3½ miles east of Port hail. But it may have been at Portbail, which is an ancient place, where the river may have fallen into one of Cæsar's estuaries.]

"LEXOBII."

Næomagus (P. adds, harbour).

Long. 19° 30′ .... 1° 13′
Lat. 51° 10′ .... 49° 31·25

[Falls 2¾ miles north-west of the Iles-Saint Marcou or Marcouf. There is nothing impossible in this. Manet says, foot note, p. 56:—"One may see, at a little distance from this coast, the two isles to which St. Marcou has bequeathed his name, and *which were themselves then part of the continent*, as M. de la Martinière has well written." These islands are now about 4 nautical miles distant from the nearest part of the coast.]

"CALETI."

[The Greek MSS. do not contain this word.]

The mouth of the river Sequana.

Long. 21° 0′ .... 0° 25·11′
Lat. 50° 30′ .... 48° 52·54′

[The Seine doubtless. I think the latitude ought to have been farther north. Ptolemy next gives positions of places further east which do not concern us, and he then returns westward over the old ground.]

But the northern littoral side from the river Sequana the CALETÆ possess, whose city is Juliobona.

Long. 20° 15′ .... 0° 49·06′
Lat. 51° 20′ .... 49° 40·93′

[Falls 27½ nautical miles east of Pointe de Barfleur, and 30 nautical miles north of the present north coast of France. This position is not necessarily incorrect merely because it implies that a vast tract of land may have been lost. The aggregate *sinkings* of the surface of the earth must have been at least as great in aggregate bulk as the *risings*; but present geological knowledge is very far indeed from having shown in detail that the former approach anything near in magnitude to the latter.]

After whom the LIXUBII.

Afterwards the VENELI. (The Unelli, no doubt.)

After these the BIDUCESII (formerly VADUCÆSII).

And the last up to the Gobæum promontory OSISMII, whose city is Vorganium.

Long. 12° 40′* .... 4° 51·21′
Lat. 50° 10′ .... 48° 33·18′

[There cannot be a doubt that the territory of the Osismii and Gobæum promontory were identical with the north-western angle of Britanny, Pliny the elder, in the 4th book of his *Natural History*, section xxxii. says:—"Lyons Gaul has the Lexovii, Vellocasses, Galleti, Veneti, Abrincatui, Osismii—the clear river Loire. But a very beautiful peninsula running out into the ocean from the end of the Osismii, 625 miles in circumference, in the neck 125 miles in breadth. Beyond the Nanneti"—viz., the inhabitants of Nantes. And Strabo says, book iv., chap. 4, sec. 1:—"The Osismii are the people whom Pytheas calls Ostimii; they dwell on a promontory which projects considerably into the ocean, but not so far as Pytheas and those who follow him assert." And Camden, *Britannia*, p. 1523—4, says:—"Over against these (the Scilly islands), on the coast of France just before the Osismii, or Britannia Armorica, lies the Island which Pliny calls Axantos, and which retains the same name, being now called Ushant." The north-western angle of Britanny is, therefore, abundantly identified as the Gobæum promontory of the Osismii. This position falls 3¾ nautical miles west-north-west of the nearest point of France,† which is a near agreement between Ptolemy and the present position of the cape. In fact the two *may* have been identical before the land mentioned by Manet (Art. 108) as having been lost, had disappeared.]

But the western littoral side below the Osismii . . . whose city is Dariorigum.

Long. 21° 45′ .... 2° 22·2′
Lat. 50° 50′ .... 47° 39·95′

[It is very remarkable that *the name of the people to whom Dariorigum belonged is not given, either by Bertius or in the Lyons edition.* The position falls about 14 nautical miles east of Vannes, and it is known not to have been really in the same position as Vannes.]

Below whom the SAMNITÆ bordering on the river Loire. Ingena.

Long. 21° 45′ .... 0° 1·16
Lat. 50° 30′ .... 48° 52·54

[Above 30 miles south of the present coast of Calvados, and near Falaise, therefore irrelevant.

In the Lyons edition of Ptolemy, 1535, we have as follows:—The position of Juliobona is given with the same longitudes and latitudes, as aforesaid. After whom the Lexobii. After the Veneli. After these the Biducenses. And last, up to the Gobæum promontory, the Osismii. And then *a blank as in Bertius for the name of the people to whom Dariorigum belonged.* The latitude and longitude of Dariorigum are the same as those already given. The Lyons edition also has "Below whom are the Samnitæ, bordering on the river Loire," as in Bertius.]

The following are from the Lyons edition.

The mouth of the river Loire.

Long. 17° 40′ .... 2° 11·55′
Lat. 48° 30′ .... 46° 56·4′

[This gives a position 6 miles west of the Isle of Noirmontier, on the French chart (which does not quite agree with Map No. 2). This former position of the river's mouth would seem to signify that a large tract of land has been lost. We are told by Strabo,‡ "they say that in the ocean, not far from the coast, there is a small island lying opposite to the outlet of the river Loire, inhabited by Samnite women who are Bacchantes, and who conciliate and appease that God by mysteries and sacrifices." And Dionysius Periegetes Alexandrinus, who wrote a very valuable geographical treatise in the time of Augustus, still extant, corroborates Strabo, by

* The Lyons edition gives the same longitude and latitude. The promontory is named Cabæum of the Ostimii, by Strabo, book I., chap. iv., s. 6.

† French Government charts, 1841 and 1843.

‡ Book IV., chap. iv., sec. 6. He died A.D. 25. He lived in the reign of Augustus.

saying: "another tract of small islands, where the wives of men from the farther coast of the famous Amnites having gone, perform the rite sacred to Bacchus." *There is now no island opposite the present mouth of the Loire.*

In Bertius's "Ptolemy" we read as follows]:—"In the middle territory, but more to the west (formerly east) than the Veneti, are the Aulerci Diabolitæ, whose city is Nœodunum,

Long. 18° 0′ .... 2° 0·91′
Lat. 50° 0″ .... 48° 23·5′

[falls near Dinan, which is given in the index of latitudes and longitudes in Mr. Keith Johnston's Atlas, 48° 26′ N., and 2° 2′ W. And we are told by Cæsar,* that the Aulerci (meaning probably Aulerci Diabolitæ) were one of the *maritime* states touching the ocean; they may, therefore, have extended from the Biducenses to Staliocanus harbour (Portrieux), or still further west, which is quite consistent with Ptolemy's description, since port Staliocanus, with perhaps a small district round it, *belonged to the Veneti,* as Cæsar tells us all the other harbours did.† Nœodunum or Dinan is east of Staliocenus. It is of special importance for the present purpose to show, as has now been done, that Ptolemy is probably correct in this part of his record.]

After whom (namely after the Andicavi and Aulircii Cenomani) the Namnetœ, whose city is Condivincum.

Long. 21° 15′ .... 1° 0·46′
Lat. 50° 0′ .... 48° 23.53′

falls far away to the N.E. of Nantes.

In the Bay of Biscay.‡

The harbour of Sicor.

Long. 17° 30° .... 2° 16·87′
Lat. 48° 15′ .... 46° 41·8′

[falls in the Ile d'Yeu.]

Promontory of the Pictonii.

Long. 17° 0′ .... 2° 32·84′
Lat. 48° 0′ .... 46° 27·3′

[from Bohiquet's large scale chart, 1858. Falls 30 nautical miles nearly due west from the town of Sables d'Olonne, in 75 mètres sounding.]

Mouths of the river Canentellus.

Long. 17° 15′ .... 2° 24·85′
Lat. 47° 30′ or .... 45° 58·3′
47° 15′ .... 45° 43·8′

[falls more than one degree due west of the west side of the Ile d'Oleron for the *first* named latitude, and 13 nautical miles due south of, and in the same longitude as the "Plateau de Roche-Bonne." The *second* latitude is 15 nautical miles south of the *first* latitude, and more than 1° due west of the nearest part of the continent. I have considered it to mean the river Charente. The Roche-duc-Sud-Est (part of the Plateau de Roche-Bonne) has only a sounding of 18 French feet; so that at all events there is nothing improbable in supposing that it may have been land. The *first* and *second* latitudes are, perhaps, in about 258 French feet soundings. From M. Beaupré's Chart, 1832.]

The harbour of the Santones.

Long. 16° 30′ .... 2° 48·81′
Lat. 46° 30′ or .... 45° 0·25′
46° 15′ .... 44° 45·74′

[falls 1° 10′ due west of the west coast of the department Gironde. Out of soundings. Measured from Mr. Keith Johnston's School Atlas, 1857.]

The Promontory of the Santones.

Long. 16° 30′ .... 2° 48·81′
Lat. 47° 15′ .... 45° 43·8′

[falls about 1° 14′ west of the "Tour de Cordouan," which is at the present mouth of the river Gironde. From K. Johnston's Atlas.

The following are from fol. 34*b* of the Lyons edition.]

The promontory beyond the west of the Pyrenees which contains degrees

Long. 45° 30′ or 20′ .... 44° 2·18′ or
.... 43° 52½′
Lat. 15° 0′ .... 3° 36·7′

Mouths of the river Aturius.

Long. 16° 30′ or .... 2° 48·81′ or
16° 15′ .... 2° 56·78′
Lat. 44° 30′ or .... 43° 4·11′ or
44° 15′ .... 42° 49·6′

Promontory Curianum.

Long. 16° 30′ .... 2° 48·81′
Lat. 46° 0′ .... 44° 31·22′

Mouth of the river Igmanus.

Long. 17° 0′ .... 2° 32·84′
Lat. 45° 20′ .... 43° 52·5′

Mouth of the river Garumna [Gironde.]

Long. 17° 30′ .... 2° 16·87′
Lat. 46° 30′ .... 45° 0·2′

The middle of its length.

Long. 18° 0′ .... 2° 0·91′
Lat. 45° 20′ .... 43° 52·5′

The fountains of the river.

Long. 19° 30′ .... 1° 13′
Lat. 44° 15′ .... 42° 49·6′

[This position is near one of the fountains of the Adour, not near any fountains of the Gironde.]

These are all of Ptolemy's positions, which it appears necessary to mention on the present occasion. The present writer accepts no responsibility in the way either of asserting or denying the truthfulness of these positions in the Bay of Biscay. When we remember that *littoral* shells (four species in one day) were dredged up by Mr. Robert Dawson, at 40 miles west of the coast of Aberdeen, and the vast losses of land heretofore exhibited on the west coast of Normandy, we ought, at all events, to be cautious how we condemn Ptolemy's positions, *merely* on the ground of their great distances from the present coast.

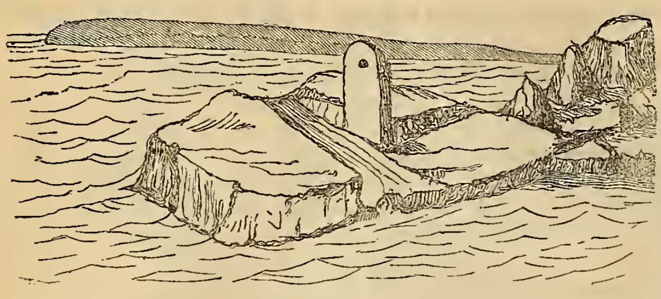
CHAPTER VII.

The Northern Channel Islands—M. Ahier. Dr. Fleming.

115. Ptolemy, whatever might be the reason, gives no latitudes or longitudes of any places near the northern Channel Islands.

116. *Sinkings difficult to identify.*—It cannot but be remembered that risings of land are very numerous all over the world, and are easily identified by the marine fossils contained. In this way it is known that the whole of North Wales has been sea bottom. But sinkings go out of sight and are often impossible to get at. It is only about 115 years since the Gorban or peat with its trunks of trees, was first discovered on the west of Guernsey. Though free from water at low water, the trees are generally covered with sand as they are at Jersey, and on the French coasts. And it is quite possible and probable, considering how many terrestrial remains have been found in or washed up from, the sea bottom — that there may still be many terrestrial remains at the bottom of the Channel Islands' seas, constantly below low water and covered with sand, too. It is, therefore, peculiarly difficult to follow out sinkings, and we must be content with such evidence as can be obtained. Dredging promises to be a prolific source of evidence of sinkings. When we remember the results of Mr. Robert Dawson's dredging just mentioned and that Mr. Gwyn-Jeffreys and his colleagues have had similar successes, we may look hopefully forward to this resource. Before the present writing is in print, Mr. Rose, of Jersey, will doubtless be plying his dredge on the south of that island, in what (as we have seen) there are reasons for believing is the estuary of the ancient river Tetus. Mr. Gwyn Jeffreys dredged up fossil shells in 1865, near the south-east angle of Guernsey.

* "De Bello Gallico," Book II., Sec. 34.
† "De Bello Gallico, Book III., sec. 8.
‡ From the Lyon's edition, folio 34*b*.



Percee Rock.

117. Near the south end of the isle of Herm (about one-quarter mile distant) on its west side, is a rock called as above, because it is pierced (*i.e.* percée). In the sketch the spectator is supposed to be looking westward towards Guernsey, which appears in the distance. The boatmen say a gate once hung there, which is a well known tradition. High water of an ordinary tide is about 12ft. above the hole through the upright stone or post, the view being taken near low water. There are certainly many gate posts, similar in form, now in use both in Guernsey and Jersey. There is something like a road in front of the pierced stone or post, of 7ft. wide, and level transversely for a length of 20ft., so that a horse and cart could travel along it with great ease now, for that distance but no farther. The sides of this (so called) road, one side being hidden in the sketch by the large rock on the left, are at right angles with the road itself; that is to say in cross section, the road is horizontal and the sides are vertical, and the depression must, I think, be artificial. The pierced stone does not appear to have been cut out of the solid, but to have been inserted in the the rock.

118. The writer was favoured in May, 1860, by the receipt of a letter from F. C. Lukis, Esq., of Guernsey, from which the following is an extract:—"The report of a gate hinge being fixed to a rock at the northern extremity of Guernsey has no foundation, beyond the same vulgar notion which is found in other places, both here and in Britanny. There is a similar statement often made of a gate being once placed among the rocks at the south end of the Herm. This is derived probably from an artificial perforation on the prominent rock called La Percée, which most likely had a buoy or float in ancient times attached to it, in order to guide the boatmen into the harbour of la Rosiére." M. de Gerville gives at p. 36 of his pamphlet aforesaid, a copy of a charter extracted from the chartulary of Cherbourg. He says also, "et l'archiviste m'en a depuis communiqué l'original." The charter being very short, a translation of it is now given:—

"Know all men, that we, brothers of the order of Minors of the Isle of Herm, near Guernsey, of the diocese of Coutances, while living, have renounced and do renounce all right of possession, property, or perpetuity of the said island, nor do we intend to remain to the prejudice or loss of the venerable lords, abbots, and convent of Cherbourg, of the order of S. Augustin there, but the buildings there being made safe by us or our* brothers, if they should happen to expel or remove us from the island in any manner. Given under the seal which we use, and under the hand of the president of the same place, by the advice equally and consent of all the brothers now dwelling in the said island, on Friday, the day after the feast of B. Mary, to wit, of the Assumption, in the year of our Lord, 1440. It is evident as to the interlineation of *nostros*. Given as above. [Signed] F. J. Doube. Verum est."

This convent, therefore, was inhabited in 1440, which would necessarily lead to frequent communications with the neighbouring large island of Guernsey, for provisions, &c., and would cause a necessity for one or more buoys or mooring posts.

119. But it is submitted, especially to naval men, that the pierced stone would have been odd and awkward and unprecedented apparatus to have erected for the purpose of fastening a boat or buoy to. Would not a more obvious and natural course have been, to let in and fix with melted lead, a stout iron bolt with a ring attached, into the centre of the large flattish rock to the left? Two men could easily have done this in one tide; but, providing and conveying the stone, cutting the cavity, and fixing the stone in position, would have been attended with a good deal more trouble and expense. And, at any rate, the theory of the post having been erected to fasten a buoy to, does nothing toward accounting for the cutting away the rock to a level and rectangular form as before described. The writer has no wish to insist too much on this latter point; such (apparent) excavations have been known to occur naturally, and the present instance is possibly natural. He visited the rock September 6th, 1861.

120. The reader will observe that if the post, &c., were formerly above high water, a gate *may* have hung there. And this theory only requires that the same sort of sinking should have taken place at Percée, which has occurred at so many places. Of course the reader will judge for himself whether the stone has, or has not, been a gate-post. The hole, which is similar in size and situation to those in very many gate-posts, is in the oldest of them filled with a wooden plug tightly driven in, through which the pointed end of the piece of iron, forming the upper hinge of the gate, is driven, and generally clenched on the other side. In modern times the iron hinge is *leaded* into the hole in the gate-post. The gate, if ever there was one, must (according to precedent) have shut, not across the (so called) road; but across the level space which runs from the nearest side of the post to the right. It is said that the hinges of a gate could be seen not many year since on the Hanois rocks, on the S.W. of Guernsey.*

121. Mr. Lukis states, as follows, date May 25th, 1869:—"The littoral deposit of peat [on the N.W. of Guernsey] called Gorban by the natives, is frequently exposed by the tides, and as, in the case of the largest extent of that substance in Vazon Bay, consists almost entirely of low meadow trees, and paludinous vegetation (the hazel nut has been found therein, and I have a seed vessel of a wild damson, probably the *Prunus Insititia*) from that place. The deposit is, however, at present confined within a narrow belt off the shore and usually in the flat portion of the bays of the islands. I have not obtained any peat from soundings in the deep parts of the Russels, or any from the Casket rocks. These submerged forests may date with the same catastrophes which have created the peat beds on the north and west of the approximate shore of Britanny and Normandy. Lately, on the south-east of Vale Castle,† a portion of a peat bed was uncovered by the contractors of the new breakwater, and a quantity of Roman coins (large brass) were picked up by the men."

On this it may be remarked as follows:—How does Mr. Lukis know that the deposit of peat and trees is confined within a narrow belt off the shore? Nothing short of an elaborate series of borings in deep water could have justified his making such a statement; and there is no reason to believe that any such series of borings was ever made: While on the other hand, there is a certain of probability that there *may* have been a wood at as much as 3½ nautical miles west of Guernsey, from the circumstance of a rock there being called "Roque *au Bois*," on the charts; and from the farther circumstance of another group of rocks, half way between it and the shore being called "Grunes *du Bois*." Further particulars are given in Art. 145, in the latter part of which article reasons are stated showing how very improbable it is that those names can (as has been suggested) have been given in a capricious and unauthorised manner, by pilots, fishermen, or vraic-gatherers. Secondly, neither the hazel nut nor the wild damson are necessarily "low meadow trees." Thirdly, the plum tree is one of the family *Rosaceæ*, no fossil plants of which have, according to Agassiz, ever yet been discovered; so that the submersion of the forest must have taken place later than the formation of the most recent fossils. And, fourthly, we shall see at the end of Art. 146, that Roque *au Bois*, and Grûne *du Bois*, cannot have been derived from the deposit at either of them at drift, or wreck wood. Because the two groups

* The word "nostros," *our*, appears to have been interlined in the original.

* Tupper's History, p. 28.

† Between Guernsey and Herm.

of rocks are only dry for an hour or two at low water of spring tides, and consequently, such moveable wood cannot have remained there long enough to give names to the groups of rocks.. It is worth while to requote Mr. Lukis's important testimony from the "Archæological Journal." He is unintentionally one of my best witnesses in favour of the sinkings. Speaking of a cromlech at L'Ancresse Bay, on the north side of Guernsey, he says:—"At the period it was constructed *the sea was at a greater distance from the site of the hill than at present*, for the *whole neighbourhood bears marks of the inroads of that element:* the near approach of the sandy hills around it was caused by *those events which have so materially changed the coast of these islands, as well as that of the opposite continent.*" The italics are mine. Mr. Lukis and I are agreed as to the facts, and I am trying to account for them, and will presently produce important corroborative testimony, as to these localities, from Julius Cæsar and Diodorus Siculus, who were cotemporaries of each other, and lived some half a century before Christ.

Mr. W. B. Herapath, F.R.S., *On the Genus Synapta*,* says that several were found in Bellegrave Bay, on the coast of Guernsey, a little below low water level at spring tides, in a bed of sand about 10in. or 12in. deep. "The sand-bank was dark in colour, and fœtid from the large quantity of decaying animal matter therein. The Synapta doubtless fed upon that refuse material by gorging itself with sand from time to time." Were these fœtid matters the produce of a similar decay of a prodigious quantity of insects and plants, to that which occurred in the submerged marshes of Dol; mentioned in the latter part of Article 72 ?

On the 13th August, 1866, the writer was sailing from Jersey to England, and a gentleman aboard informed him that there are remains of walls in the sea bottom below low water to the north of the Isle of Lihou, and that Dr. Mansell has seen them. Dr. Mansell, however, in a letter dated Sept. 18th, 1866. states that he has not seen them, and being well acquainted with the locality, he is "quite satisfied that none exist." Another gentleman also spoke to the writer in the Geological Section of the British Association, at Nottingham, and stated that there is a sunken tower off Herm. Dr. Mansell states in the same letter that he has heard a tradition to that effect, "but there is nothing of the kind to be seen now." Mr. Lukis, of Guernsey, has also kindly sent me a long letter on the same subjects, from which I quote, the date is Sept. 22nd, 1866.—"The causeway from the mainland across the low bay of Lihou, exhibits the work of man, and within my memory several fresh *paved paths* have been constructed by the States of this island, for the convenience of carts and horses, during the wracking seasons. These of course may be observed by travellers, or boats as they pass over at full tides, but I have never heard of the facts related in your letter, and I may safely contradict the statement of your travelling acquaintance. My frequent visits to the little Island of Lihou, where I have resided for near two months at one time, whilst prosecuting the examination of the church and priory in 1838, allow me the opportunity of speaking with confidence upon this rumour. In tracing and examining their *egout* upon the coast limit of the island, I am sure that no further, or lower buildings, or walls ever existed.

"As to the peat marsh lands where the 'Gorban' is dug out, no doubt these were once once somewhat below the present meadows, at the foot of the range of hills, and they would, consequently, be more exposed to submergence, whilst the upper level would rather increase from accumulation, or disintegration of the rocks forming the land above.

"The quality of the timber likewise, which is found in our submarine peat, would rather denote a late origin, for we find the birch, the oak, hazel, and prunus; trees subsequent to the *older* periods of the British Channel. Again, the animal bones and stone instruments, which accompany our gorban or peat, bring us into connection with the early history of our race. In the Gorban we find grass, reeds, and paludinous vegetation, which agree with our *recent* period." Of course, the animal bones and stone instruments worked by man in older periods, may have been deposited centuries before the ground sunk, and have sunk with it, in comparatively recent times.

Mr. Lukis proceeds:—"La Rocque Percée is, from its position at the end of a ridge of sunken rocks, round which it is necessary to [sail to] reach the anchorage of la Rosaire, and no doubt it was pierced for the purpose of having a buoy or ballaie float attached to it, to guide the mariner on entering the little bay near it,—a similar rock is said to be seen near the little harbour of la Pezerie, near Rocquaine Bay, which has, from its perforation, been called a gate-post." The concluding sentence of Mr. Lukis's letter, referring to a specimen of an oak tree 20ft. long, which he kindly sends me, is given as the last paragraph of Article 151.

He and Dr. Mansell have effectually demolished the alleged walls north of Lihou, as well as the alleged submarine tower near Herm. I leave it to the reader to form his own judgment as to the signification of Percée rock, from a consideration of Articles 117 to 121, both inclusive.

122. *Is there any originality in this investigation?* The reader will have observed that evidences have been diligently collected, here a limb and there a feature, and that an attempt is being made to build up a truthful record of the former conditions of the localities previous to the vast changes which have certainly taken place. We say the evidences have been "diligently" collected; for if it was worth while to take any trouble at all, it was worth doing as well as the writer could do it. And indeed it was absolutely necessary so far to sift the matter, that no future revelations could affect the doctrines and principles set forth. Farther researches are more likely to bring to light fresh sinkings, than to afford reasons for doubting either the extent or degree of those revealed in these papers. But it has been said, "there is no originality in these enquiries," and that "all is collected from books." This saying is nothing new, a similar delusion occurred long, long ago, which was as follows:—I remember to have read that a portion, at least, of the ancient Greek populace, said there was no originality about the illustrious sculptors, Polycletus, Phidias, and Praxiteles. And that they were only men who knew which block of marble contained a statue, and when they had got the right block all they had to do was to cut away the superfluous marble. That was all, and very comical it was! In the present case an attempt is being made to cut away superfluous ignorance. If any one still thinks it an easy matter to trace vast physical changes like these, through seven hundred miles of space; and nineteen centuries of time; or whether he thinks it easy or not—it is to be hoped in the interest of science, that he will sit down and try in some other case. The sinkings, of the actuality of which I am trying to convince the reader,—when considered with reference to their grandeur and recency combined,—are so extraordinary, that nothing short of thorough investigation can be satisfactory, which has accordingly been aimed at by carefully working out the details. And knowing that the interpretation put upon the events narrated is the true one, I think it my duty in the interest of science, to add to that interpretation whatever force can be derived from the following letter. By previous arrangement with Sir Roderick Murchison, I sent to Mr. Bates, the assistant secretary, an abstract of these papers and a chart, which in due time produced the following letter:—"Royal Geographical Society, 15, Whitehall-place, S.W., March 21st, 1866. Dear Sir,—As it is probable the Council of our Society will order your most interesting paper to be published in their journal, illustrated by a map of the N. coast of France, may I ask you whether you could send us a sketch-map of the coasts, to include all that you think necessary for the elucidation of your paper. The map need only be a rough one, and should specify these soundings, rock-patches, names of places, &c., which are mentioned in your paper, to the exclusion of the vast mass of unnecessary detail existing on the chart you have so kindly sent to the society. Our engravers would produce a map suitable for our journal, founded on your sketch. Yours sincerely [signed] H. W. Bates. R. A. Peacock, Esq." Three suitable maps were duly sent to Mr. Bates.

* Brit. Assoc. Report, 1864. Trans. of Sections, p. 97, 98.

M. Ahier's Statements and Theories.

123. In *Tableaux Historiques de la Civilisation à Jersey*, par John Patriarche Ahier, 1852. The author gives a map exhibiting a much greater tract of dry land in the Channel Islands' seas than now exists. All along the west of Normandy additional land is shown, extending to, and including the Ecrehous and Dirouilles. More land is shown on the west, south, and especially on the south-east of Jersey. And, thirdly, he shows the Minquiers rocks, and all the present sea on the south, south-east, and east of them as land. This (supposed) land is represented as having been crossed in four various directions by Roman roads. And he states, at p. 93, that:—"The line of the continent commencing at the isle of Ushant, came by a curve to bear upon (s'appuyer) Guernsey and Alderney, which were only promontories of the continent, and thence to Cape la Hague. All the isles and rocks which now occupy the sea in the triangle formed by Ushant, la Hague, and Mont S. Michel, were nothing, then, but elevated points of a considerable pertion of the continent which has disappeared since." And he quotes the very few evidences already copied from him, into these papers. His ideas of the supposed method, or methods, of this submersion will be best explained in his own words, with which I only agree so far as to affirm with him, that the sinking may have averaged nearly 150ft. in the Channel Islands' seas. The gulfs he mentions are beyond our limits. Ahier says as follows, immediately after the translated passage just given:—

"L'explanation que donnent les savans de la manière dont les eaux ont pu envahir ainsi tant de terres, et surtout couper la crête de Douvres à Calais, est assez simple. Les deux grands fleuves, qui se jetaient dans les deux golfes dont j'ai parlé, serpentaient au milieu de plaines basses et marécageu ses, et sur lesquelles la mer venait sans doute se repandre dans les grandes marées. Les terres étaient détrempées sur les rives du fleuve dans lequel la mer remontait avec impétuosité, entraînant dans son reflux tout le terrain éboulé des hords; ce même travail se faisait aussi par le Nord dans le grand fleuve qui recevait la Tamise, le Rhin et les mille rivières de la Belgique et de la Hollande, de sorte que dans un temps donné, la mer démolissant tous les jours quelques parties de ses digues naturelles, a fini par s'ouvrir un passage pour se rencontrer entre Douvres et Calais.

"Quant aux terres basses de nos contrées elles avaient aussi subi un amolissement considérable, mais il fallait une révolution soudaine pour que la mer puisse nous submerger. Cette révolution eut lieu, selon les uns, par une commotion volcanique qui affaisa subitement tous nos contrées d'environ 150 pieds; selon d'autres, cela provint d'une crue énorme des eaux du globe survenue par la fonte des glaces polaires. Que ce soit la mer qui ait haussé ou la terre qui se soit affaissée, peu importe; le fait certain c'est qu'un immense territoire fut envahi, et que les Scilly, l'île de Wight, Guernsey, Auregny, et en dernier lieu, Ouessant, et Jersey, se trouvèrent des îles. Du reste si aujourd, hui la mer baissait de 19 brasses seulement on irait encore à pied de France en Angleterre, d'Angleterre à la plus éloignée des Scilly, comme aussi d'Ouëssant, à peu près en ligue droite, à Guernesey, Auregney, et la Hague."

Thus, M. Ahier and the present writer agree that an immense tract of land has been lost, but they differ entirely in opinion as to the manner of that loss, except so far as this, namely, that according to one of M. Ahiers' conjectures, the ground has sunk suddenly (affaissa subitement) 150 French feet, which are equal to 164 English feet. That is to say, it *must* have sunk not less than 120 English feet, and part of it *may* have sunk as much as 176 English feet, or thereabouts.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(*Continued from page* 258.)

Captain Tyler concludes his report to the Board of Trade as follows:—"As to the results of my observations and experiments, I have to report, in conclusion, that this scheme for crossing the Mount Cenis is, in my opinion, practicable, both mechanically and commercially, and that the passage of the mountain may thus be effected not only with greater speed, certainty, and convenience, but also with greater safety than under the present arrangements. Few would, in the first instance, either contemplate or witness experiments upon such steep gradients, and round such sharp curves on the mountain side, without a feeling that much extra risk must be incurred, and that the consequence of a fractured coupling, or a broken tire, or a vehicle leaving the rails, would, on such a line, be considerably aggravated.

"But there is an element of safety in this system of locomotive working which no other railway possesses. The middle rail not only serves to enable the engine to surmount and to draw its train up these gradients, but it also affords a means of applying any required amount of extra brake-power for checking the speed or for stopping any detached vehicles during the descent, and it further acts by the use of horizontal guiding wheels on the different vehicles as a most perfect safeguard to prevent engines, carriages, or wagons from leaving the rails in consequence either of defects in the bearing rails or of failure in any part of the rolling stock. The safest portions of the proposed railway ought, indeed, under proper management, to be those on which, the gradients being steeper than 1 in 25, the middle rail will be employed.

"There is no difficulty in so applying and securing that middle rail, and making it virtually one continuous bar so as to preclude the possibility of accident from its weakness or from the failure of its fastenings; and the only question to my mind is, whether it would not be desirable still further to extend its application to gradients less steep than 1 in 25. It would apparently be advantageous to do so not only for the sake of obtaining increased adhesion with less proportional weight, and, therefore, economical traction, but also with a view to greater security, especially on curved portions of the line.

The French Royal Commission, consisting of Messrs. Conte, Bochet, Guinard, and Perrin, made to their governments a voluminous and instructive report of the locomotive trials, which they concluded as follows:—"From the experiments which have been described, and which the commission has judged unnecessary to continue any further, and from the different verifications which it has made, the commission has arrived at the conviction—First, that the system of traction proposed by Mr. Fell is applicable for the passage of the Mont Cenis, with the engines of the type which has worked at the last trial; second, that the system presents no danger as regards the public security on steep inclines and on sharp curves, since, on the contrary, the existence of the centre rail furnishes a guarantee against getting off the rails, and at the same time a powerful means of stopping the trains; third, that with the exception of some points of detail, the study of which has not yet been made, but which presents no serious difficulty, this system may, from the present time, be considered as applicable to the crossing of the mountain That with regard especially to the working of the line during the winter season, the covered ways proposed by Mr. Fell will be sufficient to secure the regularity of the service."

The reports of the Italian, Russian, and Austrian Commissions were equally favourable and conclusive.

The practicability of the new system having now been completely established, the French and Italian governments, in the months of November and December last, granted concessions authorising the construction of the railway on the imperial postal road over the Mont Cenis. They reserved a width of 6 metres or the ordinary traffic of the road, which, the normal width being 10 metres, left 4 metres, or about 13 English feet, for the railway.

A general description of the works of the line, and of the traffic, may be seen in Captain Tyler's reports, which have been printed by order of the House of Commons.

Early in the present year a company was formed in London, of which his Grace the Duke of Sutherland is president, for carrying out the undertaking.

The works were commenced in March last, they are now about half finished, and it is expected the rails will be laid throughout before the end of the year ready for opening in the month of April or May next.

When great tractive force has been required it has hitherto been impossible to reduce the weight of the locomotive engine below the amount of the traction force multiplied by the co-efficient of adhesion. No great inconvenience arose from this necessary loading of the engine in the case of drawing heavy trains on easy gradients, but on exceptionally steep gradients, such as those on the Mont Cenis, and when the adhesion is frequently unfavourable, nearly the entire power of the engine would be absorbed in drawing its own weight.

The practicability having been established of obtaining adhesion by the pressure of horizontal wheels on a central rail, the weight of the engine may now be reduced to simply that which is necessary for producing and carrying the power required for the traction of the train.

This advantage of the centre rail system has been brought into operation in constructing No. 2 engine, which, with only the same weight, has 50 per cent. greater power than No. 1. The economy of weight has been effected by an improved arrangement of the machinery, and by using an improved quality of material. In place of four cylinders and two distinct engines for working the two sets of wheels, No. 2 has but two cylinders and one engine, the frames and supports for carrying the horizontal wheels have also been much simplified. The external shell of the boiler, the wheels and axles, and chief parts of the machinery have been made of steel instead of iron. And the weight thus saved has been employed for increasing the capacity of the boiler, No. 2 engine having 600ft. of heating surface and 10ft. of grate area as compared with 420ft. of heating surface and 6ft. of grate area in No. 1, without exceeding the same gross weight.

No. 2 engine, weighing 16 to 17 tons, can, it has been shown in the trials, easily maintain 160 to 170-horse power, or one-horse power to each 2cwt., which is a result equal to the best constructed engines in use at the present time, and the additional weight of the horizontal wheel machinery has been compensated for by the saving effected by the use of steel.

The question of economy of weight in locomotive engines is one which it has been difficult hitherto to approach, but in centre rail engines it is a subject of improvement deserving the most serious consideration, as it is evident

that the useful or paying load may be increased in the proportion that the weight of the engine is diminished.

In the trials of steam fire engines it was reported that some engines weighing only 32cwt., with the carriages, pipes, &c., developed 32 horse-power, or double that of the best locomotives. The latter require to be built with greater stability, and to carry larger supplies of fuel and water; but, on the other hand, an engine of 200 to 300 horse-power may be made with greater economy as regards weight than one of only 32 horse-power.

Supposing, then, it should be possible, by further improvements in the construction, to build locomotives of the same degree of lightness as those steam fire-engines, the weight of the trains might be more than doubled without any increase of the weight of locomotives, or otherwise, keeping the same weight of train, the speed might be doubled, and the passage of the Mont Cenis be made by the mail trains in 2½ hours, instead of 4½ hours.

Adhesion, or the bite of the driving wheels of the engine on the rails, being the property by which its mechanical power is converted into tractive force, and being a most variable element in different states of the weather, is a question of much interest and importance in the problem of working locomotives on steep inclines. Adhesion, it is well known, is so affected by atmospheric causes as to vary from a fourth to a twelfth, or less, of the weight on the driving wheels. When obtained from pressure, it may be increased to any required amount up to the limit of the resistance to crushing of the materials employed, and Mons. Dumery, who has designed a centre rail engine for the Baron Seguier, proposed to put a pressure of 90 tons on one pair of wheels. This appears excessive, and on the Mont Cenis the pressure on one pair of horizontal wheels will not exceed about 20 tons. As, however, every ton of pressure increases the frictional resistance by 20lb., the economical expenditure of power requires that the needful amount of adhesion should be obtained with the least possible degree of pressure, and hence the necessity of securing the most favourable condition of adhesion, especially by preventing it from falling to a very low minimum, such as from a twelfth to a fifteenth, or even a twentieth, which happens at times when a very great weight or pressure must be employed. Various methods have been suggested for this purpose. Some engineers, maintaining that adhesion is the result of the interlacing of the minute particles of the substances in contact, recommended the use of a narrow rail, on the ground that this action is increased in the proportion that the area of the surfaces in contact is diminished. But I cannot learn that such a conclusion is borne out by experience; on the contrary, in low states of adhesion it has been repeatedly observed when a heavy mineral train has had to pass from one form of rail to another, under exactly the same circumstances in all other respects, that there has been less slipping on the broad than on the narrow rails. When the rails have been in a very slippery condition, the running of a wagon before the engine has been found to produce a good effect. Jets of steam and water thrown upon the rails have also been employed; but the, perhaps, only satisfactory and sure remedy hitherto in use is the application of a pure silicious sand, with which one-sixth or one-seventh of adhesion may always be obtained. A very small quantity of sand, if properly supplied, is sufficient, and anything more than is absolutely needful is injurious, because it is apt to fly into the working parts of the machinery and increase the wear and tear.

For the working of mountain lines, such as that of the Mont Cenis, with a mean gradient of 1 in 17 for 24 miles, and at some seasons of the year a climate most unfavourable from the effects of snow, frost, and fogs, it would be highly desirable if some means could be devised for cleaning the surface of the rails, and for improving the state of adhesion as the trains advanced, and so of dispensing to a great extent with the use of sand. Such an operation, probably, could not be performed at high speeds; but at such speeds as from 5 miles to 10 miles an hour, on the steep gradients, it might be possible, especially for the vertical surfaces of the centre rail, which, being raised 10in. to 12in. above the sleepers, offer greater facilities for the purpose than the carrying rails.

Cutters might be attached to the engines and to the snow ploughs for crushing and clearing away the frozen snow and ice in the winter, and in the season and region of mists some convenient machinery could probably be contrived for removing that almost imperceptible film of moisture which diminishes the adhesion to nearly the same extent as ice.

Indeed, during the experiments of the Mont Cenis I observed that on the whole the adhesion was the best in the winter seasons, there being no rain or moisture, the snow falling and remaining for some months in the state of a perfectly dry powder. It will be borne in mind that in places where the snow accumulates to any considerable depth the line will be protected by a covered way for a distance of 8 to 9 English miles, and here the rails will always be in a good condition. It may even be found economical for the working to throw a light covering over the rails on the steep gradients for a greater distance, and thus always secure a fifth or sixth, in place of a tenth, of adhesion, which would represent a saving of about 6-horse power in trains requiring a tractive force of 4 tons at a speed of 6 miles per hour, or from 3 to 4 per cent. in the cost of traction.

There can be no doubt as to the usefulness of any feasible plan for improving the state of adhesion on railways, especially on mountain lines, and the question will probably receive all the consideration it deserves.

I now wish to invite the attention of the meeting to the construction of centre-rail engines and carriages, and to certain conditions essential to the success of the system which developed themselves during the trials.

There are but few railways that are worked with one class of engines; usually, at least, two classes are employed—one adapted for the passengers, and another for the goods traffic. On the Mount Cenis, besides the two kinds of traffic, we have two distinct and totally different sections of the line. From St. Michel to Lanslebourg is a distance of 24 miles, with a mean gradient of 1 in 60, and a very short length of 1 in 12, and from Lanslebourg to Susa a mean gradient of 1 in 17, the prevailing gradient being 1 in 12. Consequently there appeared to be a more than usual necessity and advantage in employing two separate types of engine; and I proposed to adopt for the heavy gradient section an engine capable of developing a great tractive force at a slow speed, and for the section with alternating steep and flat gradients another form of engine that should at once be able to take its load up an incline of 1 in 12, and to run at a higher velocity on the easier portions of the line, since there would be a saving of time in the journey, and probably also in the cost of traction by such an arrangement.

In the engine designed for the steep gradient section of the line the vertical and horizontal wheels are of the same diameter, and are driven by one pair of cylinders. The latter set of wheels are supported by cradles or carriages, sliding laterally in the frames of the engines, and are brought nto contact with the centre rail by the compression of twelve volute springs, six on each side, by means of which 24 tons pressure can be put upon the centre rail. The machinery is simple and accessible, and the movement of the two sets of wheels is perfectly coincident; so that there is no friction or scrub between them. The power is transmitted from the cylinders direct to the cranks of the horizontal wheel-axles by the connecting rods, and to the cranks of the vertical wheels by means of a rocking shaft at the leading end of the engine, the two arms of which are so fixed that at mid-stroke one arm is at a right angle to the piston-rod, and the other arm at a right angle to the line of the outside connecting rod, which latter is placed in an oblique position between the arm of the rocking shaft and the crank of the vertical wheel-axle. Two horizontal cog-wheels are employed to help the crank of the gripping wheels over the dead poins.

The compressing gear is so arranged that the pressure on the horizontal wheels can be regulated by a hand lever on the foot plate while the engine is running.

The brakes are applied to the outside wheels, but act on the inside ones, although through the medium of the connecting and piston rods. There are also brakes that grip the centre rail, and by the two sets a break pressure of 60 tons is obtained on an engine weighing only 16 to 17 tons.

The engine proposed for working on the section of the line having a mean gradient of 1 in 60, differs from the one just described in the following respects:—

It would have four cylinders placed parallel to each other at the leading end of the engine, by which the vertical and horizontal wheels would be driven independently of one another, the latter working on those portions of the line where the centre rail was laid, and the former being of larger diameter would enable the engine to travel at increased speeds on the more level portions of the line.

The advantage of this arrangement would be considerable, and in consequence of the saving thus effected more time could be allowed for the really difficult part of the journey. This engine would be somewhat heavier than the other, but since the elevation to be attained on the St. Michel section is less than half that on the Susa section, this increase of from 1 to 2 tons in the weight would not be of much consequence.

The present No. 2 engine might be adapted for running on both sections of the line, though at a sacrifice of speed and an increase of wear and tear; the only advantage being that, having but one type of engine, the repairs could be more easily provided for. The principal modifications required are that the toothed wheels should be altered or changed for some other more convenient arrangement, as they do not work well when off the centre rail, and that the weights on the carrying wheels should be more nearly equalised; the latter modification is to a certain extent desirable even for working with the centre rail and at a slow speed, but essential when running without the guiding steadying power of that rail and at an increased speed.

The wheel base of No. 2 engine is 6ft. 10in., with an overhang at the leading end of 6ft. 2in., and at the trailing end of 7ft. 10in. There is, consequently, a load of about 11 tons on the latter, and only 6 tons on the former axle. This irregular distribution of weights, together with the great overhang at speeds of 12 to 15 miles an hour, causes a pitching motion, with a certain amount of percussion on the bearings and a tendency to get off the line when only running on two rails. This pitching motion on the axles, one of which is loaded up to 11 tons, would be destructive to a road laid with a light Vignoles rail like that of the Mont Cenis. On the experimental line, with the protection afforded by the centre rail, at comparatively slow speeds, and with a bearing rail of 75lb. to the yard, these defects were not of much importance; but these can, of course, be remedied in the engines now being made for actual service of the Mont Cenis.

The carriages, as well as the engines, are each furnished with four horizontal wheels, which have flanges under-lapping the centre rail; these act both as guide and safety wheels, preventing the carriages from leaving the rails, and by guiding them round the curves greatly diminish the frictional resistances and the tractive power required.

With regard to the advantages of the application of the centre rail system for the construction of railways in mountainous countries, I cannot do better than repeat the observations of Captain Tyler on the subject in his report to the Board of Trade, which are as follows:—

"Whenever it becomes necessary to cross a chain of mountains by a line of railway, the question arises as to wether it will be more economical to pass over the summit or to make a tunnel of greater or less length. The cost of construction and of working the estimated traffic being duly considered, it is necessary to determine what elevation should be reached, and what length, if any, of tunnel should be formed, according to the circumstances of each case, and the most important element in the calculation is the limit up to which steep gradients may be safely and economically worked.

"Mr. Fell has shown practically that gradients of 1 in 12 to 1 in 15 may, by a system of horizontal driving wheels acting upon a middle rail, be substituted for 1 in 25 to 1 in 30, which have hitherto been practicable, and that sharper curves may also, by this system, be more safely worked. He has proved, in other words, that a railway may be constructed over a given summit of half the length that would otherwise have been necessary, and at less than two-thirds the cost, because although the permanent way would be more expensive, averaging say £3,000 instead of £1,800 to £2,000 a mile; yet, by the adoption of steeper gradients and sharper curves at critical points, cuttings or embankments may be reduced or avoided, and the works generally be more cheaply laid out. And the cost of working and maintenance would, considering the same elevation to be reached, be cheapened as well as the cost of construction. There would be half of the length of line to maintain and the speed of the trains would be reduced. Only half the speed would, indeed, be required to reach the summit in the same time, and the same gross loads might be taken up by the same expenditure of power at the speed so reduced to one-half, while the adhesion of the locomotive engines being doubled, with the addition of no more than a sixth to their weight, an important saving would thus be effected in the dead weights of the trains. The cost of traction which must, in taking a given gross load to a given height be nearly the same, would not increase so much in consequence of the saving of dead weight thus effected, and other expenses would decrease to some extent in proportion to the wear and tear and resistances incidental to a higher but avoided at a lower velocity.

"A summit line may, for these reasons, be made with greater facility in less time, and to greater advantage than heretofore, and it will be interesting, taking the Mont Cenis as an example, to compare the cost of the tunnel now in course of construction under that mountain with a permanent line which might be made over it. I do not make the comparison with a view to that particular case, because it may now be taken for granted that the permanent tunnel line will be completed within a certain number of years, and because the summit line projected by Messrs. Brassey and Co. is only put forward as a temporary line to be used pending the opening of the permanent line from St. Michel to Susa, but as being important with reference o other mountain passes in the Alps and elsewhere.

The temporary line is estimated, by Mr. Brunlees, C.E., to cost 8,000,000f. or £320,000, or about £6,720 per mile, whereas the tunnel line will probably cost, including interest at 6 per cent. during construction, 135,000,000f., or £5,400,000, or £128,500 per mile, the latter being 68 kilometres (42 miles) in length, with a maximum gradient of 1 in 28, and a gradient through half of the grand tunnel of 1 in 45½, and an average gradient for the whole of 1 in 46, and the former being about 77 kilometres (about 48 miles) in length, with a maximum gradient of 1 in 12, and extra elevation of 2,500ft.; and the time occupied between St. Michel and Susa would, including stoppages, be about three hours by the tunnel and four and a-half hours by the summit.

"The cost of a permanent and independent summit line with a wider guage and better curves may be taken at £20,000 a mile, or nearly three times as much as the above temporary line, and the extra cost of working over a super elevation of 2,520ft., based upon a traffic ten times as great as that which is carried at present over Mont Cenis, and upon the average cost of traction (0·25 of a franc, or 2½d., per horse power per hour) upon the Sommering and Giovi inclines, capitalised, at 6 per cent., at £13,000 per mile. These two sums added together amount to £33,000 per mile, or rather more than one-fourth of £128,500 per mile, set down above for the tunnel line.

"This estimate would of course be materially modified by local circumstances; but it is as good an illustration as can be given at present of the advantages that may be derived in cases in which stationary engines and inclines worked by ropes, are not appropriate for constructing railways on steeper gradients than have hitherto been considered practicable in the manner in which Mr. Fell has now shown to be available.

"The Italian Government commissioners, in their report, state that, taking into account the interest on capital employed, and working expenses in both cases, the cost of carrying passengers and goods by the Mont Cenis tunnel line would be 17c. per passenger per kilometre, and 21c. per ton of goods per kilometre, and 6c. per passenger, and 10c. per ton of goods, or about one-third, by the summit line.

"That the great tunnel would effect a saving of thirty-eight minutes in the time of the journey between France and Italy by the passenger trains, but the cost to the state would be 86,172,211f., or £3,446,889 sterling in excess of that of the summit line.

It has been observed that the weight of an ordinary locomotive engine must be equal to the tractive force it is required to develope, multiplied by the co-efficient of adhesion, consequently the limit of its tractive power is its weight divided by the adhesion.

It may be interesting to inquire what is the limit of the tractive force of the centre rail engine, and the limit of the gradient up which it could take a load? Pressure having been shown to be equivalent to weight, we have in this case the weight of the engine, plus the pressure on the horizontal wheels, divided by the adhesion. Now, since the pressure may be increased in proportion to the strength and hardness of the materials employed, and the area of the surfaces in contact, it is practically unlimited, and so, in consequence, is the tractive force that can be exerted by a centre rail engine, and the gradient up which it can ascend.

Let us take an extreme case for an example. The length of the Italian portion of the Mont Cenis Railway from Susa to the summit is seventeen miles, and the vertical ascent in that distance is one mile. This part of the journey ~~has to~~ be performed, according to the programme, in two hours, or at the rate of half a mile an hour for the vertical distance. No. 2 engine maintained throughout the official trials a tractive force of over 600lbs. at a speed of ten miles per hour, or a power equal to a tractive force of 120,000lb., or 52 tons at the above speed of half a mile an hour. It may seem a somewhat extravagant hypothesis, but for the sake of illustrating the argument let us suppose it were possible to fix a vertical rail one mile in height for the ascent of the Italian side of the Mont Cenis, and to employ a vertical engine with wheels gripping this rail for the ascent, drawing behind it carriages similar to those of the common "hoist." Let us see what load the engine would carry, and what amount of adhesion would be required to perform such an extraordinary journey.

The weight of the train will be equal to the tractive force employed, less the portion absorbed by frictional resistance, or 52 tons—4 tons=48 tons, from which deduct the weight of the engine, 17 tons, and we have a gross load of 31 tons drawn vertically at a speed of half a mile an hour, which duty, the gravity of the engine included, would require 151-horse power, and a pressure on the gripping wheels, when there was a fifth of adhesion of 240 tons, and with a tenth of adhesion of 480 tons. To provide the necessary adhesion there must be twelve pair of these wheels, with 20 tons pressure on each pair, as proposed for the Mont Cenis, or three pair with the amount of pressure on each proposed by M. Durucry, in the former case, and double that number in the latter case.

It is thus theoretically practicable to make a centre rail engine ascend a vertical rail with a load, and with about the same expenditure of power and time that would be required with the same load to ascend an incline representing the hypothenuse of a triangle of which the vertical rail would represent the perpendicular.

Consequently the centre rail system or the application of the principle of obtaining from pressure the adhesion required for developing tractive force on railways, is not restricted to gradients of 1 in 12, the maximum inclination on the Mont Cenis, but is equally applicable to any other steeper gradient, and that consistently with the economical expenditure of mechanical power.

The boiler of No. 2 engine contains 600 square feet of heating surface, and is capable of maintaining 171-horse power, allowing 3½ square feet of surface to each horse power.

To carry a gross load of 40 tons—viz., engine 16 tons, train 24 tons—over the Mont Cenis in four and a-half hours, stoppages included, 166-horse power are required, which, with 600ft. heating surface, will leave 3·61ft. to each horse power.

Total heating surface—sq. ft.	Horse-power.	Heating surface to each horse-power.	Gross weight of train.	Weight or load carried.	Ratio of weight of useful load to gross weight of train.	Speed on gradient of 1 in 12. Kilometres per hour.	Average speed crossing the Mont Cenis. Kilometres per hour.	Time of crossing, stoppage included.	Description of train.
		sq. ft.	Tons.	Tons.	Per cent.			Hours.	
600	166	3·61	32	16	50	15	22½	3½	Express.
600	166	3·61	36	20	55	13½	20	4¼	Mail.
600	166	3·61	40	24	60	12	18	4½	Mail.
600	166	3·61	48	32	66	9½	14	6	Mixed.
600	166	3·61	80	64	80	6	9	8	Goods.

The same mechanical power being employed the speed of the train will be increased in the proportion that the weight is diminished, and the weight may likewise be increased in the proportion that the speed is diminished, as shown in the foregoing table:—

Locomotive Trials for the French, Italian, and Russian Governments. Summary of Distances and Speeds.

	Time employed.	Distance run. 24 tons load.	Steam pressure gained.	Time employed.	Distance run. 16 tons load.	Steam pressure gained.
			lb.			lb.
July 19—3 runs, 24 tons load ...	1·00	10·920	75			
2 „ 16 „ ...				0·30	7·280	70
July 26—1 „ 24 „ ...						
1 „ 16 „ ...	0·10	2·000	10	0·14	3·640	20
July 27—2 „ 24 „ ...	0·36	7·280	45			
1 „ 24 „ ...	0·17	1·729	10			
2 „ 16 „ ...				0·27	7·280	47
July 29—5 „ 24 „ ...	1·48	18·200	100			
July 31—3 „ 24 „ ...	57	10·920	56			
3 „ 16 „ ...				0·41	10·920	67
23	4·48	51·040	296	1·52	29·120	204

With 24 ton loads 51·040 kilometres, divided by 4h. 48min., equal 10·704 kilometres per hour; with 16 ton loads 29·120 kilometres, divided by 1h. 52m., equal 15·600 kilometres per hour.

Steam pressure gained, 500lb. in twenty-three runs, viz., 20lb. each run with 24 ton load, and 25lb. each run with 16 ton load.

In introducing a new element into the locomotive engine, and applying it to a purpose for which it has hitherto been deemed unfit, there have been considerable difficulties to encounter and prejudices to overcome, the latter especially in the minds of those engineers who have had no opportunity, or have not taken the trouble to investigate the merits of the system for themselves.

The governments interested in the passage of the Mont Cenis have, however, treated the matter with the greatest fairness and liberality. His Majesty the Emperor of the French, and the eminent statesman at the head of the Italian Ministry, have fully appreciated the advantage their countries might derive from the introduction of a system of cheap mountain railways, and have from the commencement given the enterprise their cordial and powerful support.

The centre rail system, once perfected and put into operation on the Mont Cenis, is no doubt destined to confer similar benefits on other parts of the world, and put into communication countries and people at present separated by obstacles insurmountable by railways of the ordinary description; and those who for years have laboured at this work may, as a reward for their anxieties, now rest with the conviction that they have accomplished an object which will in some degree contribute to the advancement of science and civilisation.

SECTION G.—MECHANICAL SCIENCE.—SHEATHING IRON SHIPS.

Mr. S. J. Mackie read the following interesting paper "On Zinc Sheathing for Iron Ships:"

The philosopher, like the man of the world, by the study of the causes of temporary misfortunes, finds out the roads to permanent success. When 400,000 tons of iron shipping are yearly constructed at our six great building stations on the Thames, the Clyde, the Mersey, the Tyne, Wear, and Tees, and this large quantity has to be multiplied year by year to represent only the bulk of one moiety of the enormous merchant fleets of Great Britain, when to this vast mass of British private shipping we have to add the important item of the iron-clads of our navy, we may form some idea of the magnitude and the importance of finding some reliable and perfect means of protecting this enormous amount of property from unnecessary destruction and decay. Nor can we confine the subject within even national limits. Other countries have their iron merchant fleets and their warlike navies, and so while iron ships are sent as iron ships to sea with no protection from wind and water, from rust or fouling, but some utterly inefficient coat of paint which stops not, and only barely hides the mischief which is working out beneath—the question of sheathing iron ships is and will remain one of universal interest—an interest affecting not only the salvation of a vast amount of wealth, but too often the salvation of many lives. We have long known the great extent of deterioration to which iron ships are subjected—and we have equally long known, too, that the rapid fouling of iron ships has utterly debarred private shipowners and our large commercial companies from sending iron sailing ships on long voyages. Wooden ships of old were subject to all the annoyances of fouling, until the plan of copper sheathing was adopted—the thin coating of that metal, which possesses under the action of sea the property of always keeping a bright clean surface—why not, then, sheath iron ships with copper? Because it could not and can not be done. The contact of the copper with the iron sets up electro-chemical action, and the iron is destroyed—the whole ship is converted into a galvanic battery, and its iron skin perishes with more rapidity than if left alone. Still the plan was tried in many ways—the copper was insulated by wood, by gutta-percha, and india-rubber. Glass was tried instead of metal, and like Admiral Belcher's smelling-bottle, in the Arctic Seas, was quickly covered over with barnacles and weeds. So years have rolled away, and still our iron ships are sent to sea, and—although some of our national defences cost a million of money apiece—nothing effectual has been done as yet by merchants, shipowners, or government—at home or abroad. The results so recently obtained at Portsmouth from experiments upon Mr. Daft's well-considered plan of sheathing iron ships are so important that I have deemed it an absolute duty to draw the attention of this association to them, and particularly to the whole system of zinc sheathing, and to the novel method of putting together the skin of the ship by which the zinc or any other metal plates can be directly applied to its surface. I alluded in my opening words to the advantage to philosophers in misfortune. Mr. Daft, like a true philosopher, has converted the knowledge of the cause of the great evil in iron ships into the best and most reliable means for their protection. To cure evil we must do good, and the good is the reverse of evil. Just so with the greatest simplicity of thought (for all the sciences, like truth itself, are simple and comprehensible by all), Mr. Daft has argued—If the galvanic action set up by salt water between copper and iron causes the accelerated destruction of the iron, could we not, by substituting for the copper some other metal which should stand in galvanic relationship to the iron, as in the former case the iron stood to copper—that is, if we could find a metal which should be electro-chemically positive to iron—we should have a galvanic battery constituted by the ship, and the sheathing would be the element to be destroyed and the iron the element to be preserved. Now, there is but one available metal that would effect this end, and that is zinc, a metal commercially much cheaper than copper. Will zinc, then, do for sheathing? Will it decompose too fast and require frequent replacing, or will it not decompose fast enough to prevent fouling? These questions Mr. Daft set about solving by practical, patient experiments, in the same quiet, simple, satisfactory, natural way as he first conceived the original idea. The author then showed clearly the difference of effects produced by the action of salt water upon copper and iron, and iron and zinc respectively, in metallic contact, by exhibiting small strips of those metals which had been immersed in two glasses of salt and water the day previous. The results, by a happy accident, Mr. Mackie was able to make visible to the meeting. To bring the plates to the meeting he had wrapped the two pairs of elements in separate papers, and those which had constituted the copper and iron battery had, during the few minutes of their carriage to the meeting-room, deeply stained the enveloping white paper to a deep ochreous tint, while the papers containing the iron and zinc elements, although subjected to exactly the like treatment, remained free from any visible stain whatever. Mr. Mackie then pointed out in detail the method which had been proposed for constructing the skins of iron ships in such a manner that by caulking the seams with teak a perfect water-tight joint was made, and a plain flush surface secured for the whole hull of the vessel. He also showed that fouling would be prevented entirely by this process of zinc sheating, because the galvanic action of the iron and zinc in sea water secured sufficient exfoliation of the exposed surface to keep the zinc as clean upon an iron ship as copper on a wooden one. He also described the practical experiments which had been made at the direction of the Admiralty at Portsmouth, where zinc-sheated iron plates which had been submerged in different parts of the harbour for from ten to sixteen months had been taken up during the past month in the presence of Sir John Pakington and other lords, with not only the iron perfectly free from corrosion, but the zinc sheathing bright and clean, without any barnacles, weed, or other indications of fouling whatever. These and many other details were given in simple, intelligible language, and were illustrated by an actual rivetted specimen, some 2ft. square, caulked with teak and partially sheathed with zinc, representative of the actual skin of an iron ship. The speaker further indicated how the galvanic action between the iron skin and the sheathing could be modified to any degree of required intensity of galvanic action, and how builders could form flush hulls upon this plan without its being necessary to plane the edges of the iron plates to absolute smoothness, as was now obliged to be done in making "butt" joints. "And now," he concluded, "having briefly—I hope intelligibly—put before you the methods Mr. Daft has devised, and which, after mature consideration and experiment have been found to possess a real and meritorious value, I would urge that the greatest good that can be done to his plans is to detect and criticise every point that seems not merely defective, but to fall short in any way, however slight, of absolute perfection for the purpose for which it was devised, knowing full well that Mr. Daft has refrained from putting his views too quickly before the world—preferring to spend time and money upon satisfactory proof and satisfactory investigations, so that at last he might come forth with his methods substantiated in their value by those best of credentials, the record of practical tests; for, whatever short-comings or omissions there may have been on my part, or whatever further may be desired to be known by anyone, every possible facility for information will, I am sure, be given by Mr. Daft, whose most earnest desire now is that his invention should be convincingly proved to be the proper means of preserving iron ships and be adopted by shipowners and builders and the government. And here, in conclusion, let me add that, as the retention of wood as a material for the construction of ships going to India, China, Australia, and other long voyages is almost entirely due to the present absence in use of any means of preventing fouling except by copper or yellow metal sheathing, which from their destructive action cannot be applied, so the furnishing of a reliable means for putting on a

safe and cleau keeping metallic sheathing will add to the present iron ship building trade—will double the amount of business by bringing into the hands of the iron ship builders the construction of the necessary means for carrying on all our great national distant commerce."

Mr. Vignoles read a paper ou the part of Captain Wynadts, of the Belgium Artillery "On Barytic Powder for Heavy Ordnance," which stated that this powder was produced by the substitution of uitrate of Barytes for saltpetre in the composition of gunpowder, tbe consequence of which was that the powder ignited and consumed more slowly, whereby the gases diminished less rapidly; so that while there was the same effect on the velocity of the projectile, there was less injury to the mouth and vent of the chamber of the gun.

A description was read by Mr. W. D. Gainsford of "A Newly-invented System of Ordnance." It stated that the system had for its objects to construct a gun which shall be capable of throwing heavy shot with comparative lightness of metal in the gun itself, with a recoil little exceeding the indispensable reaction of the projectile; to obtain with each gun an initial velocity of projectile equal to if not greater than that of a smooth-bore gun, and to maintain it to a greater extent than any rifled guu; to be light in metal, not more than twenty-three times the weight of the shot thrown; to be inexpensive in mauufacture, to be as durable as the smooth-bore gun, and to be quick and easy of management. The defects of existing ordnauce arose from one cause—frictiou. It was urged for the proposed system that friction would be much reduced. The gun consists internally of two parts, a chamber for the powder, aud a barrel or receptacle for shot. The barrel is very short, so that when loaded, the front of the disc of the projectile is laid within the mouth of the gun. Direction is given by the close-fitting of the sides of the barrel to the disc, rotated by a piu passed through the barrel iu its lower part, so as to take hold of a notch cut in the cage of the disc, the effect being that au effective rotation is obtained, aud, from the absence of friction great initial velocity is secured, while the recoil is small from the same cause, the only recoil being that due to simple propulsion of the shot. Experiments which had been tried with the gun on board her Majesty's ship *Cambridge*, at Devonport, at 1,000 yards, with a 4lb. shot and 6oz. powder, and at a range of 2,000 yards with the same charges, had beeu successful.

DUPLEX BORING MACHINE.

(*Illustrated by Plate* 308).

In the accompanying plate we have illustrated a boring machine. designed by Mr. Birckel, for the special purpose of boring out the cylinders of Mr. Thomas Duncan's patent water meter manufactured by Messrs. Wyllie & Co., of the Vauxhall Foundry, Liverpool.

These meters, which resemble in their main features to rotative water pressure engine, are provided with two cylinders, cast in one piece, whose diameters vary from 2⅝ins, to about 5ins., according to the bore of the pipe which the meter is intended to supply, while the distance of their centres varies from about 6¼ins. to 11¾ins.

In the earlier days of tbe use of these meters the cylinders were bored out upon the face-plate of a lathe, but as they have lately come into more extensive use it became necessary to devise means for lessening the cost of their manufacture in order to meet as far as possible the demand for cheapness on the part of the consumer, and one of the principal desiderata was to supersede the expensive labour of the turner, by the much cheaper labour of the machine man, and at the same time to bore out the two cylinders simultaneously by means of a contrivance which would suit the whole series of meters in ordinary use.

In the pursuit of this object the obvious difficulty met with was to hit upon an arrangemeut for adjusting the centres of the boring bars to the varying distances of the centres of the cylinders, and yet to set both into motion by means of one driving gear only in order to ensure simplicity of construction aud easiuess of handling of the machine.

This difficulty was happily overcome in the following manner:

The bed plate, which resembles generally that of an ordinary slide lathe, with fast head stock cast in a piece with it, is provided with first motion shaft, fitted with cone and pinion carried ou one side of the head stock; this pinion gears into a wheel keyed upon the main driving shaft, whose centre is placed exactly into the plane of the longitudinal axis of the bed plate. This shaft carries also two pinions, the one placed outside the headstock, and the other inside of it, an arrangement which it was necessary to adopt in order to bring the centres of the boring bars to within the nearest distance required. Tbese pinions gear into two intermediate wheels, placed respectively on the right and left hand side of the driving shaft, whose centres are moveable in vertical slots, and these wheels again gear respectively into wheels keyed upon each of the boring bars, to which motion is thus finally communicated.

The bars have their bearings each in a sliding block resting in a horizontal slot in the headstock in which the distance of their centres may be made to vary from 6¼in. to 11¾in., and the intermediate wheels are accurately kept in gear with those ou the bars by raisiug or lowering them in tbe vertical slots provided for that purpose; the range of vertical displacement of these wheels does not exceed 1in., that is ½in. on either side of the horizontal plane passing through the centre of the driving shaft, so that the position of their pitch lines with reference to the driving pinions is uot sensibly disturbed by this vertical displacement. Had the range of displacement been greater, it would then have been necessary to make the slots concentric with the driving shaft.

Tbe off-ends of the boring bars are carried by a moveable headstock and sliding beariugs, similar in every respect in tbeir arrangement to that adopted in the fast headstock, and these have tbeir faces properly indexed for expedition in setting the bars to the distance required for the several sizes of meters, by which arrangement also the parallelism of the bars, with the longitudinal axis of the bed-plate, is continually insured. When these are set to any required distance, they are securely fixed into place by screwing down the caps of the headstocks, and also by means of a set screw with which each of the sliding bearings is provided.

Tbe boring bars are slipped through the cylinders, to be bored out by drawing out the loose headstock, after which the cylinders are bolted on to a sliding table which receives an intermittent feed motion by means of a screw from a cam cast into one of the intermediate wheels through a system of levers, rod, pall and ratchet wheel; the screw is carried through tbe end of tbe bed-plate, and when a pair of cylinders has been bored out, the table is drawn back by working the screw by hand after having thrown the pall out of gear.

This machine has turned out a complete success, boring out the cylinders with a fine smooth face, at about one-fifth the cost incurred by the old method.

THE PARIS EXHIBITION IN 1867.

Now tbat the British executive has, by the outward and visible sign of taking oue of the palaces in the Champs Elysées, located itself unmistakably in the French capital, it will not be thought unseasonable if we enter somewhat upon the functions it is charged to perform on behalf of, and towards, the exhibitors of the United Kingdom. The materials we here lay before our readers, are chiefly condensed from an article on the subject lately pnblished in a daily contemporary:—

The invitation for the United Kingdom to take its place at the Paris Universal Exhibition in 1867, was officially announced in tbe *London Gazette* of May, 2nd, 1865. The Queen, in appointing the commissioners, whose names we append below, notified that estimates were "to be submitted to our Commons House of Parliament for tbe purpose of affording the necessary assistance to be administered through the Department of Science and Art, as the Lord President of our Privy Council and Vice-President of the Council of Education for the time being, may direct." Tbe commissioners in this missive were appointed to advise upon the best mode by which the products of industry aud the fine arts of the United Kingdom aud British colonies and dependencies may be procured and sent to the Exhibition. The commission gave full power and authority to nominate and appoint other persons to be commissiouers, and to name and appoint jurors for the Exhibition. Tbe French Imperial commission issued a chapter of certain general regulations, which were approved by Imperial decree of the 12th July, 1865. These regulations were divided into three sections. Section 1 treated of the general arrangements and system of classification; Section 2 set forth the special arrangements relative to works of art; and Section 3 provided tbe special arrangements respecting the products of agriculture and industry.

The regulations specially applicable to British and colonial exhibitors may be thus epitomised:—

Section 1. The first article declared tbat the Universal Exhibition, to be held at Paris in 1867, will be open for the reception of works or art and of the products of agriculture and industry of all nations. It will be held in a temporary building on the Champ de Mars. Around the Exhibition building a park will be formed for the reception of cattle, and other live

DUPLEX BORING MACHINE.

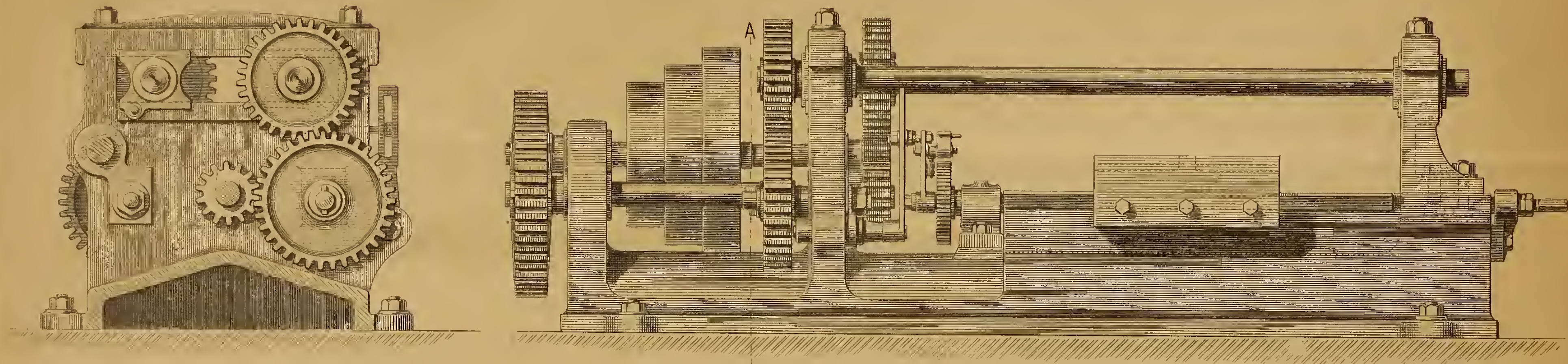


Fig. 3. Section at A.B.

Fig. 1. Side Elevation.

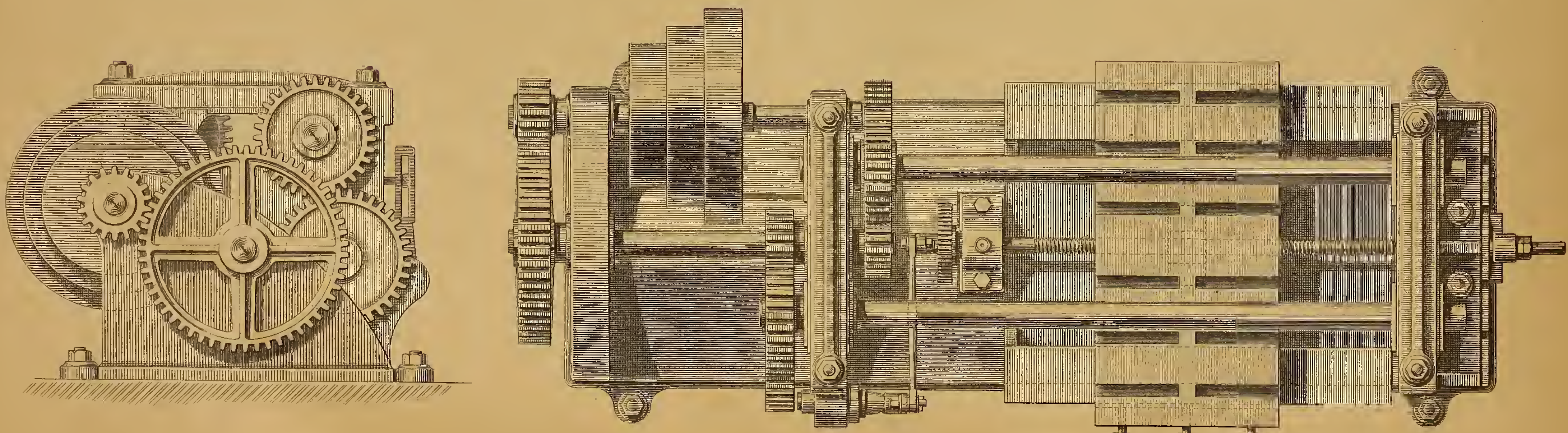


Fig. 4. End View.

Fig. 2. Plan.

W. Smith. E. C. direx.

animals and plants, as well as for those constructions and objects which cannot be exhibited in the main buildings. The Exhibition will open on the 1st of April, 1867, and will close on the 31st October following.

It is necessary to remind exhibitors that the opening day is the 1st of April instead of the 1st of May, which we have adopted for the opening day of our universal exhibitions. It was announced in Article 5 that the French Imperial commission would not correspond with foreign exhibitors, who were referred to the commissions of their own governments. Products sent by a foreign exhibitor can only be admitted through the medium of the foreign commission which represents him. The foreign commissioners are to provide as they may see fit for the carriage, the reception, the arrangement, and the return of the productions of their countrymen. The 7th Article declared that, in order to facilitate the division of the space allotted to each country between the various classes of objects enumerated in Article 11, the Imperial commission placed at the disposal of the representatives, for their guidance, the plan of the arrangement of the French section of the exhibition building drawn on a scale of 2 millimetres to a metre (1in. to 41·6ft. or $\frac{1}{500}$). This plan shows the arrangement of the glass cases and counters suitable for each class of objects, as well as the shape, height, and other dimensions of the courts intended for each class. An analogous plan of arrangement, showing the manner in which the portions of the Exhibition building allotted to each foreign country will be subdivided, was transmitted to the Imperial commission before the 31st October, 1865. Plans in detail, on a scale of 2 centimetres to the metre (1in. to 4·16ft., or 1), showing the place allotted to each exhibitor and to each separate stall, were also forwarded, with the list of exhibitors, by each foreign commission before the 31st January, 1866, in order that in arranging the interior of the Exhibition building the Imperial commission might be able to take into consideration the wants of each country. By the 8th article each foreign country was to claim, for the formation of a special park, the portion of the Champ de Mars adjoining the space allotted to it in the Exhibition building. The representative of each foreign commission was to settle with the General Commissioner the plan of the paths for the circulation of the public and of the earthworks which will be executed at the cost and under the direction of the Imperial commission. Article 9 declares that an official catalogue of the products of all the foreign countries will be drawn up, showing the place which they occupy either in the Exhibition building or in the park. This catalogue will contain the alphabetical lists—one of the exhibitors, the other of the products exhibited. Foreign commissioners were further requested to send the information necessary for the preparation of the catalogue before the 31st January, 1866. Article 11 stated that in each section assigned to the exhibitors of the same country, the objects will be divided into 10 groups and 95 classes, viz. :—

First Group.—Works of art. (Classes 1 to 5).

Second Group.—Apparatus and applications of the liberal art. (Classes 6 to 13).

Third Group.—Furniture and other articles intended for dwelling houses. (Classes 14 to 26.)

Fourth Group.—Clothing (including fabrics) and other articles worn on the person. (Classes 27 to 39).

Fifth Group.—Products (raw and manufactured) of mining. (Classes 40 to 46).

Sixth Group.—Instruments and processes of the common arts. (Classes 47 to 66).

Seventh Group.—Food (fresh and preserved) in various states of preparation. (Classes 67 to 73).

Eighth Group.—Live products and examples of agricultural establishments. (Classes 74 to 82).

Ninth Group.—Live products and examples of horticultural establishments. (Classes 83 to 88).

Tenth Group.—Objects exhibited with the special purpose of improving the physical and moral condition of the people. (Classes 89 to 95).

By Article 12 it was declared that no work or object exhibited in the Exhibition, or in the park, may be drawn, copied, or reproduced in any manner whatever without the authority of the exhibitor, who is the author of it. The Imperial commission reserves to itself the right to authorise the taking of general views of the Exhibition.

Article 13 specified that no work of art or object exhibited may be removed before the close of the Exhibition without the special authority of the Imperial commission.

Art. 14, Sec. 1.—Under the foregoing provisions published by the Imperial commission, the Lords of the Committee of Council on Education received demands in the United Kingdom amounting in the aggregate to more than 300,000 superficial feet of net horizontal exhibiting space; whilst the space placed at their disposal by the Imperial commission amounted to about 70,000 superficial feet of net space, which is partitioned into groups by the Imperial commission, thereby leaving a more limited scope of adjustment within the powers of the British executive than in 1855.

As in the Paris Exhibition of 1855, and other international exhibitions, each local committee has been invested with power to allot such space as may be thought right to each exhibitor, or to reject the demands of any exhibitor or exhibitors, or to apply the whole space placed at its disposal to a collective representation of the staple industry of the locality.

The local committees of the United Kingdom allotted space only in respect of local manufacturers, as separate committees had been requested to deal with the demands in the other sections of the Exhibition as follows:—For architecture and the arts cognate thereto, the committee of the Royal Institute of Architects; for machinery, the council of the Institution of Civil Engineers; for agricultural implements and live stock, a joint committee, consisting of members of the Royal Agricultural Society of England, the Highland Society, and the Royal Agricultural Society of Ireland; for horticulture, the Royal Horticultural Society; for photography, the Photographic Society; and for manufactures (metropolis), the associate committee of the metropolis for particular classes.

The instructions embraced by section 11, which affected the special arrangements relative to works of art, were no less precise. Works by French and foreign artists executed since the 1st January, 1865, will be received for exhibition, but neither copies, including those which reproduce a work in a manner different to that of the original, nor oil paintings, miniatures, water colour paintings, pastels, designs and cartoons for stained glass and frescoes, without frames, nor sculpture in unbaked clay are to be admitted.

In a further circular, addressed to possessors of works of art and industry whose co-operation is desired, the Imperial commission has announced that a display of works characteristic of the various "epochs of the history of labour" will be desirable. A special gallery, situate around the central garden and within the circumference of the gallery of works of art, is to be devoted to this purpose. This exhibition will consist of the works produced in various countries down to the end of the 18th century, and will even comprise in the products of the early epochs of the human race previous to the discovery of metals.

Collectors of remarkable works of past ages were invited to assist.

The object which the special committee appointed to organise the French section propose to attain, is, to make known, by exhibiting the remarkable objects left to us, the principal epochs of the art and industry of our ancestors. They desire, in addition, by a methodical classification, to show clearly and in chronological order the progress, the changes, and the decline of national labour.

The Imperial commission adds its readiness to receive objects appertaining to the French section that may be in the possession of collectors in other countries. The commission has every reason to hope that "the foreign commissioners, to whom a communication has been addressed on this subject, will make reciprocal arrangements with French collectors, and is ready in such cases to receive the proposals of the latter, in order to transmit them to the proper authorities."

The Epochs of the History of Labour adopted for the classification of the works exhibited in the French section have been carefully defined from the time of Gaul, anterior to the use of metals down to the period of the Revolution (175 to 1800).

The following is the list of the executive and secretaries for classes, &c., for the United Kingdom :—

At the head of the official list appears the Lord President of the Committee of Council on Education, his Grace the Duke of Buckingham and Chandos; with the Vice President of the Committee of Council on Education, the Right Hon. H. T. L. Corry, M.P.

The immediate executive is composed of—Executive Commissioner, Henry Cole, C.B.; Assistant Executive Commissioners, R. A. Thompson and P. Cunliffe Owen; Secretary, R. G. Wylde; Chief Clerk, A. J. R. Trendell; Clerks, A. H. Gasparini, A. S. Bury, F. R. Fowke, M. M. Cundall, W. L. Pringle.

The secretaries for classes who attend to all inquiries and applications from exhibitors are :—

In Group I.—Fine Arts, Classes 1 to 5, Messrs. Samuel Redgrave, H. A. Bowler, Eyre, Crowe, Charles A. Collins, A. C. King, A. S. Cole (stained glass).

In Group II.—Apparatus and application of the Liberal Arts. Class 6, Printing and Books, Rev. W. H. Brookfield. 7, Paper, Stationery, &c., G. C. T. Bartley. 8, Applications of Drawing and Modelling to common Arts, H. A. Bowler. 9, Photography, Captain J. F. D. Donnelly, R.E. 10, Musical Instruments, P. B. B. Peile. 11, Surgical Instruments, F. Seymour Haden, F.R.C.S. 12, Mathematical Instruments, &c., Captain J. F. D. Donnelly, R.E. 13, Maps, &c., G. C. T. Bartley.

In Group III.—Furniture and other objects for the use of Dwellings. Class 14, Furniture, E. P. Bartlett. 15, Upholstery and Decorative, Work, E. P. Bartlett. 16, Crystal and Stained Glass, R. H. Soden Smith, 17, Porcelain and Earthenware, R. H. Soden Smith. 18, Carpets,

Tapestry, &c., Ernest Corbière. 19, Paperhangings, E. P. Bartlett. 20, Cutlery, C. A. Pierce. 21, Plate and Jewellery, R. H. Soden Smith. 22, Bronzes and Repoussé Work, R. H. Soden Smith. 23, Clocks and Watches, R. H. Soden Smith. 24, Heating and Lighting Processes Captain E. R. Festing, R.E. 25, Perfumery, C. A. Pierce. 26, Leather Work, &c., C. A. Pierce.

In Group IV.—Clothing (including Fabrics) and other objects worn on the person.—Class 27, Cotton, G. Wallis. 28, Linen, G. Wallis. 29, Worsted Fabrics, G. Wallis. 30, Woollen Fabrics, G. Wallis. 31, Silk, G. Wallis. 32, Shawls, G. Wallis. 33, Lace, &c., G. F. Duncombe. 34, Hosiery, G. F. Duncombe. 35, Clothing generally, G. F. Duncembe. 36, Jewellery and Plate, R. H. Soden Smith. 37, (See Special Committee). 38, Travelling Equipage, A. J. R. Trendell. 39, Toys, A. J. R. Trendell.

In Group V.—Products (raw and manufactered) of Mining, Industry, Forestry, &c.—Class 40, Products of Mining, Trenham Reeks. 41, Products of Cultivation of Forests, MacLeod, of MacLeod. 42, Products of Shooting and Fishing, MacLeod, of MacLeod. 43, Agricultural Products (not used as food), Dr. Frankland. 44, Chemical Products, &c., Dr. Frankland. 45, Chemical Processes for Bleaching, Dyeing, &c., Dr. Frankland. 46, Leather and Skins, W. Matchwick.

In Group VI.—Apparatus and Processes used in the Common Arts (Machinery).—Class 47, Mining, Captain Hichens, R.E. 48, Agricultural Apparatus, B. T. Brandeth Gibbs. 49, Fishing Tackle, &c., MacLeod, of MacLeod. 50, Agricultural Works, Major Malcolm, R.E. 51, Chemistry, Captain Webber, R.E. 52, Prime Movers, Captain Beaumont, R.E. 53, Machines in General, Captain Beaumont, R.E. 54, Machine Tools, Captain Beaumont, R.E. 55, Spinning Apparatus, Captain Hichens, R.E. 56, Weaving Apparatus, Captain Hichens, R.E. 57, Sewing Machines, &c., Captain Hichens, R.E. 58, Apparatus for manufacturing Furniture, &c., Captain Hichens, R.E. 59, Printing and Paper Machinery, Captain Webber, R.E. 60, Miscellaneous Machinery, Captain Webber, R.E. 61, Carriages, &c., Henry Sandham. 62, Harness and Saddlery, Henry Sandham. 63, Railway Apparatus, Major Malcolm, R.E. 64, Telegraphic Apparatus, Captain Webber, R.E. 65, Civil Engineering, &c., Major Malcolm, R.E. 66, (See Special Committee).

In Group VII.—Food, fresh or preserved, in various states of preparation.—Class 67, Cereals; 68, Bread and Pastry; 69, Milk, Eggs, &c.; 70, Meat and Fish; and 71, Vegetables and Fruit,—W. Matchwick. 72, Stimulants and Condiments; 73, Fermented Drinks,—Captain E. R. Festing, R.E.

In Group VIII.—Live Stock and Specimens of Agricultural Buildings. —Class 74, Farm Buildings, B. T. Brandreth Gibbs. 75, Horses, S. Sidney. 76, Bulls; 77, Sheep; and 78, Pigs,—B. T. Brandreth Gibbs. 79, Poultry; 80, Dogs,—S. Sidney. 81, Useful Insects, A. J. R. Trendell.

In Group IX.—Live Produce and Specimens of Horlicultural Works. Classes 83 to 88, Lieut. Colonel Scott, R.E., Captain J. Cockerell, Dr. Masters, Dr. Hogg.

In Group X.—Articles exhibited with the special object of improving the physical and moral condition of the people. Class 89, Children's Instruction, C. W. Merrifield. 90, Adults' Instruction, Dr. Appell. 91, Cheap Furniture, &c., P. Le Neve Foster. 92, National Clothing, Dr. Appell. 93, Cheap Dwellings. 94, Skilled Workmen's Work. 95, Skilled Workmen's Instruments, Major Malcolm, R.E.

History of Labour before 1800 (a loan collection of Works of Art), S. Redgrave, G. Wallis, Rev. James Beck, C. C. Black.

In the special committees for the representation of objects for the use of the army, navy, and navigation, are classed—Class 37 (including objects for the use of the army), Captain J. F. D. Donnelly, R.E., and J. W. Cooper. Class 66 (Navy and Navigation), Admiralty, Rev. J. Woolley, LL.D.; Mercantile Marine, H. E. Acton; Marine Engineering; Trinity House, &c., Commander Scott, R.N.; Yachts and Pleasure Boats, C. Wylde.

The Engineer is Captain Festing, R.E.; the Principal Draughtsman is Gilbert Redgrave; the Secretary to the Juries is Captain Donelly, R.E., with his Assistant, G. C. T. Bartley. Superintendent for Arrangement, T. Wright; Assistants, G. Wallis, W. Matchwick, T. Clack, C. A. Pierce, C. T. Thompson, Mr. Bury. Superintendent of Buildings and Park, Captain Festing, R.E.; Assistant H. Sandham. Superintendents for Machinery, Lieut. Colonel Ewart, R.E.; Major Malcolm, R.E.; Captain Hitchens, R.E.; Captain Webber, R.E.: Assistant, H. Sandham. Superintendent of Machinery in Motion, Captain Beaumont, R.E.; Assistant, H. Sandham. General Superintendent for Fine Arts and History of Labour, S. Redgrave; Assistants (Fine Arts), Captain Hichens, R.E., Gilbert Redgrave; Assistants (History of Labour), G. Wallis, C. B. Worsnop, Superintendent of Trophies and Stained Glass, A. S. Cole. Superintendent of Traffic Port, Engineering, and Refreshment Department, Major Malcolm, R.E. In the compilation of the Catalogue the Editor and Translator is G. F. Duncombe; Compiler of Statistics, H. R. Lack; Superintendent, J. Cundall. Superintendent of Collection of Literature, C. Collins. Superintendent of Agricultural Machinery, &c., C. T. Brandredth Gibbs. Superintendents of War Material, Army—War Office, Captain D. Galton, C.B. For the Marine the Admiralty is responsible; and the Superintendent of Experiments in the Testing House for Heating, Lighting, &c., is Captain Webber, with his Assistant, W. T. Rowden; and the General French Agent in Paris, who completes the list, is M. E. Cappe.

THE COMPOSITION, VALUE, AND UTILISATION OF TOWN SEWAGE.

(*Continued from page* 227.)

Table VI.

Relation of Sewage to Peruvian Guano in amount of Nitrogen reckoned as Ammonia.

If Sewage per head per annum.	Contributing 1,000 tons Sewage.	If 12½lbs. Ammonia, per head per annum, from all sources.		If 10lbs. Ammonia, per head per annum, from all sources.	
		1,000 tons Sewage = Guano.	1 ton Guano = Sewage.	1,000 tons Sewage = Guano.	1 ton Guano = Sewage.
Tons.	Persons.	Cwts.	Tons.	Cwts.	Tons.
40	25	16⅓	1220	13	1525
50	20	13	1525	10½	1900
60	16¾	11	1830	8¾	2290
80	12½	8⅕	2440	6½	3050
100	10	6½	3050	5¼	3810
200	5	3¼	6100	2⅔	7620
1 Person = Guano.		⅔ cwt.		½ cwt.	

Thus, with 12½lbs. of ammonia, and the minimum estimated dilution of the dry weather sewage at a rate of 40 tons per head per annum, 1,000 tons of such sewage would only contain nitrogen, reckoned as ammonia, equal to that in about 16⅓ cwts. of Peruvian guano, or to that in only 13 cwts. if the amount of ammonia per head per annum be reckoned at only 10lbs. In other words, in the former case it would require 1,220, and in the latter 1,525, tons of sewage to supply the ammonia (or nitrogen reckoned as ammonia) of one ton of guano. In like manner, taking 80 tons of sewage per head per annum as a minimum estimate for the average sewage, inclusive of rainfall, with 12½lbs. of ammonia per head per annum, 1,000 tons would represent the nitrogen of 8^1 cwts., and with 10lbs., 6½ cwts., of Peruvian guano; or reckening 12½lbs. of ammonia per head per annum, one ton of Peruvian guano would represent 2,440 tons, and reckoning 10lbs., it would represent 3,050 tons.

The table also shows that reckoning 12½lbs. of ammonia per head per annum, the sewage of an average individual would annually represent in nitrogen ⅔ cwt., or reckoning only 10lbs. per head per annum, only ½ cwt., Peruvian guano, per head per annum.

Crops to which Sewage is most applicable.

Hitherto, on grounds shown to be fully justified, we have, for simplicity of illustration, confined attention to the amount of nitrogen or ammonia in sewage, as the measure or indication of its composition, and of the theoretical manurial value of its total solid constituents. It is, however, obviously of interest to consider whether or not the mineral or incombustible constituents of sewage exist in it in sufficient proportion to the ammonia or nitrogen, for the requirements of the crops to be grown; and, as the phosphoric acid and potassa (the one or the other, or both, according to circumstances) are, perhaps, the mineral constituents most likely to be defficient relatively to the nitrogen, their proportion to the latter in sewage, and in various crops, may appropriately be referred to in illustration of the paint. Table VII shows the proportion of phosphoric acid and potassa to 100 of nitrogen in sewage, according to the mean of ten analyses of the Rugby sewage, in which the phosphoric acid and the potassa as well as the ammonia were determined. It also shows what may be taken as approximately representing the average proportion of phosphoric acid and potassa to nitrogen in various crops.

TABLE VII.

Amount of Phosphoric Acid and Potassa to 100 Nitrogen, in Sewage and in various Crops.

	Phosphoric Acid.			Potassa.		
Rugby Sewage	27			42		
	In Corn, Roots, &c.	In Straw, Leaves, &c.	In Total Produce.	In Corn, Roots, &c.	In Straw, Leaves, &c.	In Total Produce.
Meadow-Hay.........	...	...	27	...	...	100
Clover-Hay	...	...	23	...	...	52
Wheat..................	48	42	46	28	108	57
Barley..................	40	34	38	34	126	60
Oats......................	28	37	30	25	155	65
Beans	25	46	30	32	123	50
Mangolds	17	...	...	100	...	...
Swedes	27	16	21	82	44	63
Common Turnips ...	28	18	26	160	71	117
Potatoes	42	...	...	123	...	...

It is obvious that, since the phosphoric acid of sewage, like the nitrogen, will be derived almost exclusively from excretal matters and food-refuse, its proportion to the nitrogen will, within comparatively narrow limits, be tolerably uniform; the amount of potassa, on the other hand, will vary very much according to locality, and be considerably greater where the streets or roads are constructed of potassic minerals than elsewhere.

The table shows that, according to the analyses referred to, the Rugby sewage contained 27 parts of phosphoric acid and 42 parts of potassa, for 100 of nitrogen. It also shows that, on the average, meadow hay contains almost exactly the same proportion of phosphoric acid to nitrogen as the sewage, but a much greater proportion of potassa than the latter.*

In the cereal grains the proportion of phosphoric acid to nitrogen is, on the other hand, higher than in the sewage; whilst in most of the other crops enumerated it is much about the same. Of potassa, the proportion is lower in the cereal grains (the only part of the crop which is, as a rule, sold off the land) than in the sewage, though in the other crops it is generally higher.

But there are various circumstances, the adequate discussion of which would occupy more space than it would be appropriate to devote to their consideration here, which render it quite inadmissible to draw direct practical conclusions as to the applicability of sewage to different crops from what may appear, at first sight, the obvious indications of the figures in the table. Nevertheless, a careful consideration of the subject leads to the conclusion that, if sewage alone were applied constantly to meadow land, potassa would be more likely to become deficient than phosphoric acid; but that, if it were applied to the ordinary crops of rotation, phosphoric acid would be more likely to become deficient than potassa. Still, granting it to be clearly shown that, with this or that description of soil or management, town sewage was, in proportion to its nitrogen, deficient in this or that constituent for the production of this or that crop, or crops generally, it would by no means follow that it was an inappropriate manure on that account; for any defect in composition, whether in regard to phosphoric acid, potassa, or any other constituent, could be easily compensated from other sources.

Indeed, independently of what we know of the sources of the constituents of sewage, and can judge therefrom of their appropriateness as manure for different crops, there is nothing in the results of the analysis of the solid matter of sewage from which we should be justified in concluding that it is not applicable as manure to crops generally. On the contrary, a dry and portable manure, having the composition of the solid matter of town sewage, would undoubtedly be generally applicable both to corn and other rotation crops, and to grass; and its constituents could then fairly be valued by the same scale as other concentrated manures in the market.

But the great dilution of town sewage, its large daily supply at all seasons, and its greater amount in wet weather when the land can least bear, or least requires, more water, render it extremely inappropriate for application on a comprehensive scale to arable land, for the growth of corn and other ordinary rotation crops. But, apart from these difficulties, if sewage can only be distributed in small quantities over large areas, at such a cost to the farmer as has yet been proposed, it is indeed vain to hope that any large proportion of the manurial constituents, derived from the consumption of human food in our towns, can be redistributed over the area from which they came; for such is the limit set by climate to the amount of manure and of water applicable for crops that have to ripen their seed, that, for corn more especially, only comparatively small quantities per acre could be employed, and hence, were sewage systematically applied for their growth, the area of utilisation must necessarily be very large. On this point it may be stated that Mr. Rawlinson, one of the members of the Royal Sewage Commission, has given it as his opinion that it would cost more to distribute 500 tons of sewage per acre, by means of pipes, hydrants, and hose and jet, as would be requisite in the case of application to arable land and crops generally, than to apply 5,000 tons per acre by means of open runs, as in the case of its application to grass.

From these considerations it will be obvious, that that which may be called the theoretical value of sewage, reckoned according to the constituents it contains, is not necessarily its practical or available value when used in its highly diluted condition. It will be also obvious, that in that condition it is most appropriate for grass, for which it can be employed at all seasons, and in comparatively large quantities on a limited area, and that it is the least appropriate for crops which have to ripen. The question arises—what is the practical or realisable value of the constituents of sewage when they are utilised in the condition of dilution in which they exist in that fluid? This point will be illustrated by reference, both to the results of direct experiments, and to the experience of practical men who have utilised sewage with a view to profit.

Results of direct Experiment on the Utilisation of Sewage.

At Rugby two fields of meadow land were experimented upon; in each one plot was left without sewage, one received sewage at the rate of 3,000 tons, one at the rate of 6,000 tons, and one at the rate of 9,000 tons, per acre per annum. The experiments were so conducted through three consecutive seasons, and Table VIII summarises the results obtained.

TABLE VIII.

Quantities of Sewage applied, and of Green Grass obtained, per acre per annum, in Experiments made at Rugby.

Seasons 1861, 1862, and 1863.

Seasons.	Plot 1. Unsewaged.	Plot 2. 3,000 Tons Sewage.	Plot 3. 6,000 Tons Sewage.	Plot 4. 9,000 Tons Sewage.
	Grass obtained. Five-Acre Field.			
	Tns. cwts. qrs. lbs.	Tns. cwts. qrs. lbs.	Tns. cwts. qrs. lbs.	Tns. cwts. qrs. lbs.
1861	9 5 3 5	14 16 3 8	27 1 0 10	32 16 3 8
1862	8 3 1 10	27 18 0 18	34 10 0 19	32 9 2 22
1863	4 18 3 13	22 5 0 11	34 18 1 27	37 0 2 5
Average......	7 9 1 9	21 13 1 12	32 3 1 0	34 2 1 12
	Ten-Acre Field.			
1861	8 18 0 15	15 16 3 2	22 15 2 12	26 13 3 12
1862	16 10 0 25	27 11 0 20	32 2 1 14	31 12 1 20
1863	8 0 3 19	25 5 1 8	30 11 2 12	34 19 1 21
Average......	11 3 0 10	22 17 3 1	28 9 3 13	31 1 3 18
	Averages:—the three years and both Fields.			
1861, 2, and 3	9 6 0 24	22 5 2 7	30 6 2 6	32 12 0 15

The five-acre field was much flatter than the other; its soil and subsoil

* According to Baron Liebig's estimates, hay contains 51 parts of phosphoric acid to 100 of nitrogen; but, having collated and averaged the results of numerous independent observers, we can see nothing to lead to the adoption of such a figure; whilst direct determinations in a number of samples of each showed in the Rugby sewaged grass 25, and in the unsewaged 32 parts.

were much more porous; the mechanical and chemical examination of samples, taken to the depth of 9 inches, showed its soil to be much more stony, to retain much less water under equal external conditions, to contain much less organic matter, much less nitrogen, much less clay, and much more sand, than that of the ten-acre field. It was, in fact, considerably inferior in natural quality and yielded, accordingly, considerably less produce without manure. Notwithstanding this, it will be seen that it gave upon the whole more total produce per acre under the influence of sewage than did the naturally better soil of the ten-acre field; and, it will be shown further on, that the sewage was in its case both more completely utilised and more completely purified.

It would be inappropriate to discuss in detail here the influence of season and other circumstances upon the produce of the different years or the respective plots. It will be sufficient to call attention to the general character of the results, and to the practical conclusions to which they seem to lead. By the application of sewage, a supply of green food was obtained much earlier and much later in the season, and the total quantity per acre was increased several fold. There was generally, though not invariably, the more produce the greater the amount of sewage supplied, the exceptions being in the wet and cold season of 1862. In the other seasons, and in both fields, there was an increase of produce with each increase in the amount of sewage applied; and the largest amounts of produce obtained at all were, in both fields, in the third season of application, and on the plots which had received the largest amount of sewage. Still, it is important to remark that the amounts of increase of produce for a given amount of sewage applied were the less where the larger quantities were employed. Experience abundantly shows, indeed, that, if the only object were to get the largest possible amounts of produce per acre, as much ss 30,000, 40,000, or even 50,000 tons of sewage might frequently be applied per acre with advantage; but, under such conditions, the sewage would be very inadequately both utilised and purified, and a minimum amount of increase would be obtained for a given amount of sewage applied.

Looking, however, both to urban and to rural interests, and to purification as well as utilisation, much more moderate applications than such as are required to yield the largest amount of produce per acre must be had recourse to. By way of practical suggestion on this point, it may be stated that, on consideration of the circumstances under which the amounts of produce recorded in the Table were obtained, it is concluded that, with an application of about 5,000 tons of average sewage per acre per annum, applied, as it must be, pretty evenly throughout the year, there might be expected, taking the average of soils and seasons, an average of about 30 tons of grass. Assuming such a produce, and allowing £4 per acre for rent or natural yield, the grass would, if sold for 10s. per ton, give a gross return of 0.53d. per ton of sewage employed; if for 12s. 6d. per ton, 0.7d.; and if for 15s. per ton, 0.9d. From these amounts there would, of course have to be deducted the cost of main distribution and application of the sewage, other expenses of the crop, and the farmer's profit, before anything was available as payment to the town for the manurial matters.

In comparison with the result here assumed, it may be observed that in the neighbourhood of Croydon, where about 250 acres are laid down for sewage irrigation, and where there are probably more than 6,000 tons of sewage annually available for each acre, from 25 to 30 tons of meadow grass, selling for from £20 to £25, are obtained per acre per annum; and, after deducting as before £4 for rent, the gross return per ton of sewage employed is from 0·6d. to 0·8d. With a somewhat similar application to Italian rye-grass, 30 to 35 tons, selling for from £25 to £30 are obtained, yielding, after deduction for rent or natural produce, from 0·8d. to 1d. per ton of sewage employed. It will be observed that in these cases the selling price of the grass is 16s. or 17s. per ton; but it is obvious that, if sewage were extensively employed for the production of grass, its present price could not be maintained.

A marked effect of liberal sewage irrigation (indeed, of active manures generally) on the mixed herbage of grass land is greatly to develope the Graminaceous plants, nearly to exclude the Leguminous, and to reduce the prevalence of miscellaneous or weedy plants, but much to encourage individual species. Among the grasses, according to locality or other circumstances, the rough meadow grass (*Poa trivialis*), couch grass (*Triticum repens*), rough cock's foot (*Dactylus glomerata*), woolly soft grass (*Holcus lanatus*), and perennial rye-grass (*Lolium perenne*) have been observed to become very prominent; two or three only remaining in any considerable proportion after some years of liberal sewage application. But sewaged produce being generally cut or grazed comparatively young, the tendency which the great luxuriance of a few very free-growing grasses has to give a coarse and stemmy later growth is not an objection, as in the case of meadows left for hay.

(*To be Continued*).

LONDON ASSOCIATION OF FOREMAN ENGINEERS.

At the last monthly meeting of members of this society, which took place on the 3rd Oct., Mr. Joseph Newton, President of the Association, and Mr. George F. Ansell, F.C.S., read papers on "Mining Accidents, and the Means of Preventing them." Mr. Newton proceeded to say that at least half a million of persons were constantly and directly engaged in raising coal from the pits of Great Britain, and in the prosecution of the work ten or eleven hundred were annually killed by so-called accidents. He said "so called" advisedly, for too many of those casualties arose from preventible causes. Last year one hundred millions of coal had been raised from the pits of this country, and, taking the average value of the mineral harvest at the low estimate of 5s. per ton, a capital of twenty-five millions sterling was thus represented. Thirty millions of tons of coal were used for domestic purposes; thus giving one ton for every inhabitant of the British Isles. Nine millions of tons were exported, twenty-five million tons more were used in the manufacture of iron, and the remainder was employed for the purposes of railway traffic, steam navigation, and other departments of national industry. One great physical evil to which miners were exposed was the defective ventilation of the pits and mines in which they laboured. Were ventilation properly carried out, it would be impossible for explosions of firedamp to take place. Such a calamity as that recently recorded in the journals of the metropolis, and which consisted in the instant destruction of twenty-four lives in a pit near Newcastle, would become next to an impossibility if the due ventilation of coal-pits had been achieved. Mr. Newton went on to show that in France, Belgium, and other coal-producing countries rewards were offered annually for the discovery of scientific and mechanical appliances for facilitating the operations of mining, and the rendering them less hazardous. In this country no such thing existed, and from year's end to year's end we went on in the same disastrous manner. After some further remarks, Mr. Newton introduced a question of the best modes of ascertaining the existence of inflammable and explosive gases in coal-pits and metal-mines. This desideratum he believed had been achieved by Mr. Ansell, and he concluded by calling upon that gentleman to explain to the members his contrivances for effecting the object.

Mr. Ansell then entered into the internal economy of coal-pits generally. He described the various safety lamps in use, their mode of action, their value, and their defects, and finally explained the principle of his own firedamp indicator. Several examples of these instruments were exhibited and explained, and the almost instantaneous rapidity with which they indicated the presence of a small percentage of gas was practically shown. The well-known law of gas diffusion governs the character of the atmosphere which surrounds the earth and regulates the admixture of the various gases of which it is composed. A knowledge of it lies at the base of Mr. Ansell's inventions. It will be sufficient to describe one form of the Ansell indicator, as they are all similar in principle. It consists mainly of a small globe of thin india-rubber filled with atmospheric air; this is mounted on a frame of wood, and has a linen band round what may be termed its equator; this band is to prevent the lateral expansion of the globe or balloon. In this condition the latter is placed below a tiny lever, upon which it is made to exert a slight pressure. If, now, any firedamp, carbonic acid gas, or ordinary coal gas, accumulates around, or is made to impinge upon, the walls of the balloon, it immediately passes through the india-rubber, and, accumulating inside, causes the balloon itself to expand rapidly. In expanding, it presses strongly against the lever above, and, raising it, releases a dent by which the terminal poles of a battery are connected, and telegraphic communication is thus effected. An ordinary alarum bell gives an immediate intimation of danger at a distance or at hand, as may be desired. Porous tile, marble, or even thin cast iron, will allow diffusion to take place through it, and the gas thus introduced into a closed vessel will press with much force on a surface of mercury, or move on a small piston, where the friction is not great.

Mr. Ansell was congratulated on resuming his seat, and a discussion—in which Messrs. Dabriel, Edmonds, Sanson, Lax, and others shared—brought the interesting proceedings to a close. Finally votes of thanks were awarded to the readers of the papers.

INSTITUTION OF CIVIL ENGINEERS.

At the meeting on the 13th Oct. the first paper read was on the "Results of the Employment of Steam Power in Towing Vessels on the Gloucester and Berkeley Canal," by Mr. W. B. Clegram, M. Inst. C.E.

It was stated that this navigation was 16½ miles in length, and level from end to end. The width at the surface varied from 80ft. to 100ft., with passing places from 150ft. to 200ft. wide, and at the bottom from 13ft. to 20ft., while the depth of water was from 18ft. to 18ft. 6in. Sea-going vessels up to 700 tons register, and drawing 16ft., could by it reach Gloucester. Prior to the year 1860 these vessels were towed by horses, at a cost of about one farthing per ton per mile, and at speeds varying from 1 mile to 3 miles an hour. At the date named three steamtugs, fitted with high-pressure engine and screw-propellers, were purchased complete for the sum of £3,000, and were placed upon the canal to do this work. Two men and one boy were employed in each tug, and the consumption of coals in each was from 15cwt. to 20cwt. every twelve working hours. In the four years ending the 25th March, 1865, 1,059,137 tons register of shipping had been towed 16 miles, carrying 1,109,334 tons of goods, at a cost of £6,400, including 15 per cent. per annum on the price of the tugs, to cover interest of money, repairs, and renewals. Applying this outlay to the tonnage of the vessels towed, it gave 1·45 penny per ton for 16 miles, or ·0906 (about one-eleventh) of a penny per ton per mile, being a saving of not far short of two-thirds, as compared with the haulage by horses. In consequence of a larger and more regular trade in the six months ending the 25th September, 1866, the cost during that period did not exceed one-thirteenth of a penny per ton per mile. Applied to the goods conveyed in the vessels in the four years,

the result was 0·865 of a penny per ton per mile. The vessels were towed either singly, or in a train, according to circumstances. Sometimes as many as nine, ten, and even thirteen laden vessels had been taken by one tug at the rate of from 3 miles to $3\frac{1}{2}$ miles an hour. The heaviest load after any one tug had been 1,690 tons of goods, in three vessels, which were towed along the whole length of the canal at a speed of 2 miles an hour. For the smaller class of vessels, the speed, as a rule, was restricted to 4 miles an hour.

The employment of steam as a towing power had been found in nearly every way advantageous. The work was greatly economised. The vessels rubbed much less against the sides of the banks, the towing power being right ahead, and not on one side, as with horses. The wear to the ropes used in tracking was reduced, and vessels could be moved along the canal in weather which would have prevented horses doing the work. The speed also was increased, and, owing to this, there was now no deposit on the sides of the canal, which formerly took place, and was difficult to remove. At present the deposit was entirely at the bottom, whence it could readily be taken out by dredging. The only disadvantage of this system, in a canal the sides of which at the water's edge were unprotected, was the additional wear at that part, caused by the constant passage of the tugs, and by the "run" of the water between the sides of the larger vessels and the banks. This action upon the banks was confined to a space of about 18in. only, one-half of which was below and the other half above the water-line. On this canal a band of good weather-stone pitching, 2 feet wide, had completely prevented the injury, presenting a face along which the water ran harmlessly. It cost about £180 per mile; but, as a set-off to this expense, there was the diminished wear of the towing path by the horses, which was considerable.

The second paper read was on the "Employment of Steam Power upon the Grand Canal, Ireland," by Mr. S. Healy.

It was remarked that on this system of navigation, which was 160 miles in length, the locks were 60ft. long and 13ft. 6in. wide; a depth of 5ft. 2in. of water being maintained upon the cills, but the trading depth of the boats was limited to 4ft. 3in. The width of the canal varied from 60ft. to 80ft., shallowing at each side, so as to admit of about 30ft. of navigable breadth in the centre. Upwards of 300,000 tons of goods are carried annually over this system in and out of Dublin.

It was observed that steam-power was applicable to canal navigation in either of two ways, and both had been attempted on the Grand Canal: first, by placing the machinery in the boats with the cargo; and secondly, by employing steam-power merely for towing boats or barges in trains. Trials had also been made with both a single and a double screw; but the latter was deemed to be unsuitable for canal purposes. In the first effort to introduce steam-power, a vessel was designed to carry cargo as well as the machinery; but her carrying capacity was found to be so reduced as to render the speculation unremunerative. Within the last two years, however, a system of hauling boats in trains, by small, but powerful steamers, had been successfully brought into use on a long level of the canal—$25\frac{1}{2}$ miles. The screw which had been proved to be the best had a width of blade at the circumference of 32in., cut away at the base to the extent that was consistent with strength; the pitch was an increasing one, varying from 5ft. 3in. to 7ft. 9in. One of these steamers towed three laden boats, each carrying 40 tons of cargo, at the rate of $2\frac{1}{2}$ miles an hour; the pressure on the boiler being 60lb. per square inch, the number of revolutions 75 to 80 per minute, and the consumption of fuel, which was one part coal to three parts of slack, being 112lb. per mile. The boats were 60ft. long, and 13ft. beam, drawing when laden 4ft. of water. On that portion of the canal upon which steam-power had been applied, horses had now been entirely withdrawn, and two steamers regularly performed a daily service both ways.

On the River Shannon, the steamers designed to carry their own cargo, had to pass through locks, which limited their length to 72ft., and beam to 13ft. 3in. They carried 50 tons, with a draft of water of 4ft. 8in., and had been most successful.

In the course of the discussion it was observed that a fourth steam-tug was now at work on the Gloucester and Berkeley Canal, and that in three weeks during the month of September last four tugs had moved 35,280 tons 16 miles at a total cost of £145 8s., being not quite one-sixteenth of a penny per ton per mile. On the Forth and Clyde and the Monkland Canals, in the year 1856, a lighter, capable of carrying 80 tons of cargo, was fitted with small high-pressure engines, placed as close to the stern as possible, and a screw-propeller. Having proved successful, engines were subsequently applied to a luggage-boat carrying 35 tons, to one of the canal ice-breakers, to masted lighters, for canal and coasting trade, carrying 120 tons, and to a mineral-barge conveying 60 tons on the Monkland Canal, and 75 tons on the Forth and Clyde Canal. All of these had answered satisfactorily, and had been precursors of seventy steamers now at work on the Forth and Clyde navigation, and from the canal to the contiguous sea-coasts. In reference to the screw tugboat *Birmingham*, which had been employed from 1855 to 1865 in hauling the barge traffic upon the summit level of the Regent's Canal—where the sectional area of the waterway traversed as compared with that of the vessels navigating the canal was about 4 to 1, except through the Maida Hill tunnel, for a length of 270 yards, where these proportions were 2 to 1—it was stated that the cost of working that vessel for the eight months ending 31st May, 1865, was £344 2s. The distance traversed was 3,519 miles; the number of barges hauled, 2,023; the gross amount of cargo conveyed, 59,738 tons, or, with the weight of the barges, 90,083 tons. The cost, including all charges, had been 1·96 shilling per train mile, 1·38 penny per ton of cargo, and ·916 of a penny per ton gross weight. On the River Severn steamtugs had been used for ten years; but now the most efficient plan was considered to be that by which small direct-acting engines were fitted in a barge capable of taking 40 tons of cargo, and of towing one, two, or three canal-boats after her, according to the strength of the stream against which they had to contend. On the Weaver navigation, a canalized river, partly river and partly canal, the employment of steam-power had been so profitable that all sailing vessels and hauling by horses were being rapidly abandoned, when dependence would be placed upon steam-barges alone. A series of experiments had been made on the Ashby-de-la-Zouch canal, for the purpose of determining whether the application of steam-power would be injurious to the canal, particularly to the banks, when it was found that no prejudicial action took place, so long as the speed was limited to 3 miles or $3\frac{1}{2}$ miles an hour.

The discussion upon "The Employment of Steam-power on Canals" was resumed at the meeting, Tuesday, 20th ult., when the following paper was also read:—"On the Smelting of Refractory Copper Ores with Wood as Fuel in Australia," by Mr. J. L. Morgan, Assoc. Inst. C.E.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.

The following is an abstract of the Chief Engineer's Monthly Report presented at the ordinary monthly meeting of the Executive Committee of this Association held at the Offices, 41, Corporation-street, Manchester, on Tuesday, September 25th, 1866, William Fairbairn, Esq., C.E., F.R.S., LL.D., &c., President, in the chair. The report embraces two months, since the Committee Meeting for August had been postponed:—

"During the last two months 568 engines and 834 boilers, have been examined, and four of the latter tested by hydraulic pressure. Of the boiler examinations, 584 have been external, 21 internal, and 229 entire. In the boilers examined, 225 defects have been discovered, 10 of those being dangerous.

TABULAR STATEMENT OF DEFECTS, OMISSIONS, &C., MET WITH IN THE BOILERS EXAMINED FROM JULY 28TH to SEPT. 21ST, 1866, INCLUSIVE.

DESCRIPTION.	Number of Cases met with..		
	Dangerous.	Ordinary.	Total.
DEFECTS IN BOILERS.			
Furnaces out of Shape	1	8	9
Fracture	2	24	26
Blistered Plates	...	4	4
Corrosion—Internal	1	20	21
Ditto External	4	26	30
Grooving—Internal	...	9	9
Ditto External	...	5	5
Total Number of Defects in Boilers ...	8	96	104
DEFECTIVE FITTINGS.			
Feed Apparatus out of order	...	2	2
Water Gauges ditto	...	23	23
Blow-out Apparatus ditto	...	24	24
Fusible Plugs ditto	...	1	1
Safety Valves ditto	1	9	10
Pressure Gauges ditto	...	14	14
Total Number of Defective Fittings ...	1	72	73
OMISSIONS.			
Boilers without Glass Water Gauges	...	...	...
Ditto Safety Valves	...	1	1
Ditto Pressure Gauges	...	...	...
Ditto Blow-out Apparatus	...	...	...
Ditto Feed back pressure valves	...	45	45
Total Number of Omissions	...	46	46
Cases of Over Pressure	...	1	1
Cases of Deficiency of Water	1	...	1
Gross Total	10	215	225

Further particulars may be given of some of the defects mentioned in the preceding table.

Injury to Furnace Crowns.—This occurred to a double-furnace boiler, and was due to the negligence of the watchman, as most of such cases are. It appears that he was getting up steam at five o'clock on Monday morning, when he filled the boiler brimfull of water, steam-pipes included, and, being alarmed at what he had done, went to call the engineer. Before doing so, however, he had opened the blow-out tap, which he either forgot or could not shut, so that the water was rapidly pouring from the boiler all the while, with two brisk fires in the furnaces at the same time. When the engineer arrived the boiler was empty, the fires burning brightly, and the plates of both furnaces overheated and seriously drawn out of shape, while, in addition, the shell of the boiler was rendered so hot, that a piece of wood lying on it was set on fire. The communication of the heat from the furnaces to the shell is an interesting fact, and in another case met with some time since, in which a fire was put into a boiler without water, similar results followed, and not only were the furnace crowns injured, but the shell of the boiler strained. It has frequently been recommended that the openings in boilers, both for the food inlet and blow-out, should be above the level of the furnace crowns, and the adoption of this in the present instance would have saved them from injury. The boiler was fitted with a scumming apparatus, but the outlet was carried down to the bottom of the shell, whereas had it been at the surface of the water, although the watchman had left it open, the furnace crowns could not have been laid bare. It is true that there must be a tap or valve at the bottom of a boiler for convenience in washing out and emptying, but this should be entrusted solely to the care of the engineer, and the spanner kept under lock and key. Were this simple suggestion generally carried out, the expense and annoyance of injury to furnace crowns through watchmen carelessly emptying boilers would be prevented.

Fracture.—One of these cases occurred at the bottom of an externally-fired boiler immediately over the furnace, the overlap of four of the ring seams being cracked through from the rivet holes to the edge of the plate, and this not at a few holes at a distance one from the other, but at a considerable number consecutively, so that the strength of the plates was seriously reduced. This boiler was stayed longitudinally by a flue tube running through it from end to end, which reduced the strain upon these seams of rivets, so that no serious rupture occurred. In the plain cylindrical egg-ended boiler there is no longitudinal stay, and hence, when the transverse seams give way, the shell tears in halves. This case is an illustration of the tendency of externally-fired boilers to fail at the ring seams of rivets, and at the same time of the advantage of having a longitudinal tie from end to end.

External Corrosion.—This case was met with at the bottom of a two-flued boiler, 7ft. in diameter, and set on a midfeather wall 10in. wide. The corrosion extended from one end of the boiler to the other, just where the plates rested on the brickwork, and the inspector easily knocked a hole through them, and found the thickness not to exceed one-sixteenth of an inch. This shows the objection to setting boilers of so large a diameter on midfeather walls, and the importance in those cases in which they are retained of ploughing out the brickwork where the transverse seams of rivets rest upon it, so that the condition of the plates may be seen at each inspection. The necessity of a satisfactory examination of this boiler had been for some time pressed upon the owner, and it will be seen that explosion was but narrowly escaped.

Defective Safety Valve.—The valve referred to was effectually held down by some machinery, temporarily stored over the boiler, which, slipping out of place, rested upon the lever and bent it out of shape. Such a case as this is but rarely met with in the boilers under inspection; but nevertheless, it shows the value of a duplicate safety-valve.

In addition to the above a dangerously defective manhole may be referred to. This manhole was unguarded, and fitted with the ordinary internal cover, secured with suspension bolts and bridges, though in a boiler 8ft. in diameter, made of plates three-eigths of an inch in thickness, and worked at a pressure of 40lb. on the square inch. The edge of the plate at one side of the hole was so rotten from corrosion, that the inspector made a breach in it with a hand chisel alone; in addition to which the plate at the edge of the opening was buckled by the pressure of the bridges, and just commencing to rend. It appeared to need but a slight additional strain, such as might be given it from an extra turn of the nuts, to force the cover completely through the hole, and thus lead to the explosion of the boiler, as in several similar cases lately reported. On the danger being pointed out, it was at once arranged that this manhole should be strengthened with a mouthpiece rivetted to the plates.

Explosions.

On the present occasion I have a long list of explosions to report, eleven having occurred since my last return, by which twenty-three persons were killed, as well as twenty-nine others injured. The details of three of these explosions, of which I made a personal investigation on the spot, may now be given. They are of considerable interest, and will confirm the view so frequently expressed on previous occasions—that steam boilers do not explode from some mysterious cause that cannot be grappled with, but either from neglect in their construction or subsequent working.

Tabular Statement of Explosions, from July 28th, 1866, to September 21st, 1866, inclusive.

Progressive No. for 1866.	Date.	General Description of Boiler.	Persons Killed.	Persons Injured.	Total.
35	July 28	Cylindrical, Return horse-shoe flue. Internally fired	2	7	9
36	Aug. 2	Cylindrical. Externally-fired	2	6	8
37	Aug. 7	Locomotive	1	3	4
38	Aug. 10	Locomotive	1	0	1
39	Aug. 21	Vertical Furnace. Internally-fired	7	2	9
40	Aug. 22	Marine Multitubular. Internally-fired	3	5	8
41	Aug. 25	Particulars not yet fully ascertained................	0	1	1
42	Aug. 27	Marine	3	1	4
43	Aug. 28	Particulars not yet fully ascertained.................	0	1	1
44	Aug. 29	Portable Agricultural. Internally-fired	2	0	2
45	Sept. 7	Ordinary Double-flue or "Lancashire." Internally-fired	2	3	5
		Total.................	23	29	52

No. 35 Explosion was due to the gross mal-construction of the boiler, and resulted in the death of two persons and serious injury to seven others. It occurred at about half-past seven o'clock on the morning of Saturday, July 28th, at a colliery, to one of two boilers which had but just been laid down for driving a new engine. They were not under the inspection of this association.

The boiler was of horizontal cylindrical construction, perfectly flat at the front end, and hemispherical at the back, having within it a single horse-shoe shaped flue, both ends of which were attached to the flat plate at the front. It was internally-fired, and had no external brickwork flues, the furnace being placed in the left hand leg of the horse shoe, and the chimney at the end of the right, so that the flames merely passed up one leg of the horse shoe and down the other before escaping to the chimney, which was made of wrought iron, and planted upon a smoke box attached directly to the front end plate of the boiler.

The length of the boiler was about 36ft., and the diameter 9ft. in the shell, 3ft. 3in. in the leg of the horse-shoe that contained the furnace, and 2ft. 6in. in the return flue, while the thickness of the metal was seven-sixteenths to three-eigths of an inch throughout, with the exception of the flat plate at the front of the boiler, which was fully ½in. There were two safety valves loaded to 35lb on the square inch, but at the moment of explosion the pressure was a pound or so in excess of this, in consequence of the steam blowing off freely while the engine was standing.

The boiler burst at the flat plate at the front end, which tore away completely from the shell, rending the connecting angle iron through the root. The shell of the boiler was thrown northwords to a distance of about 50 yards, and the horse-shoe tube as far in an opposite direction, passing in its flight over the pithead gear, and a range of four boilers, three of which had steam up at the time, driving another colliery engine. This horse-shoe flue, which was about 33ft. long and weighed about four tons, struck the ground just where the man in charge of this engine had been standing but a moment before, having run behind his engine-house for shelter on hearing the report of the explosion. Had the flue fallen to the ground a few feet short of the distance it did, it would have pitched into the range of boilers just referred to, and, since they had steam up, this must inevitably have led to another explosion. One of them was struck by the funnel of the exploded boiler, but, as it was merely a light one, being made of sheet iron, no mischief resulted. The roof of the engine-house adjoining the exploded boiler, however, was brought down as well as the

side wall and a portion of both end ones, the engineer to the colliery being buried in the ruins, though fortunately, not killed, while the fireman who was attending to the furnaces was literally blown to pieces, and the enginman thrown against the fencing round the pit's mouth, and would have fallen down the shaft had it not been guarded. The boiler alongside was lifted from its seat, and blown to a distance of about 50 yards, where it alighted on a public roadway, and had one of its plates staved in by the fall. This boiler was not completed, and five men and a boy were engaged upon it at the moment of explosion. Three of them were working outside, and of these one was killed, and the other two seriously scalded and bruised; while two boiler makers and a boy at work inside were carried away with the boiler and rolled over in it, all three being cut and bruised, one of them very seriously.

There cannot be the slightest doubt as to the cause of this explosion. The boiler was defective both in design and workmanship. In boilers made with horse-shoe shaped flues, the ends do not receive any support, as they do in those of Lancashire and Cornish construction, from the flue tube running directly through the shell, and thus not only tieing the two ends securely together, but at the same time materially lessening the amount of pressure on them by reducing the area on which the steam acts. It is imperative, therefore, that the horse-shoe shaped flue should be secured to the shell by substantial stays, which, however, in the present instance had not been done, and the omission was fatal. The flue tube was merely supported on cradles, and not bound by any longitudinal stay to the shell; while the mode of stiffening the flat plate at the front end was most defective. There were five gusset stays above the furnace, but these were of the roughest workmanship. They did not run back for more than 2ft., and were attached to the cylindrical portion of the shell with but three rivets, from which, as might have been expected, they tore away. Below the furnace mouth there was no gusset stay at all, while the plate was weakened by a manhole, which, as well as another in the cylindrical part of the shell, was not strengthened by any mouthpiece. Added to this, the angle-iron, attaching the front end plate to the shell, was not welded up into an entire ring as it should have been, but was in four separate pieces, connected by common jump joints.

This boiler, which had not worked four days before it burst, was designed by the engineer to the colliery, and made on the spot by their own men, as well as the one alongside, which was of very similar and equally dangerous construction, and would inevitably have exploded in the same way as the other had done on being set to work. The case is altogether one of the most glaring mismanagement, and the lives of the poor men who were killed have simply been lost through the mal-construction of the boiler, the design and workmanship of which were alike defective.

No. 39 Explosion occurred at a quarter past nine o'clock on the morning of Wednesday, August 22nd, to a boiler on board a screw steam yacht, not under the inspection of this Association.

The yacht had been ordered on a cruise and was just moving out of the dock in which she had been lying, in order to sail down the river and take her owner on board, when her boiler exploded, killing three persons as well as injuring five others, and seriously damaging the vessel. The engineer was blown overboard and half way across the basin into the water, whence his lifeless body was extricated by drags about an hour afterwards. His wife and another woman on board at the time were both killed, the body of the former being blown to the north end of the lock and her head to the south, while the latter was picked up dead in the forecastle. The vessel was gutted, the deck torn up, the engine, the funnel, as well as the masts and rigging, blown overboard, and pieces of the wreck scattered about the quay in every direction, the boiler being hurled across the basin and thrown to the ground at a distance of 60 to 80 yards, passing over the stern of the vessel in its flight, and a little to the port side of the helm; while the end plate of the boiler, which divided into two pieces, flew in the opposite direction, one part being caught in the forecastle, and the other probably falling into the water, as it could not afterwards be found.

The boiler, which was a new one, having been put on board in January last, and only worked for a few short trips since then, was of the multibular marine type, being internally-fired, and the furnaces—of which there were two—running into a flame chamber at the back of the boiler connected to the smoke box at the front by a number of small return flue tubes passing over the furnace crowns. The shape of the shell was that of a short horizontal cylinder flat at both ends, having a diameter of 6ft. 6in., and a length of 5ft. 9in. It was worked at a pressure of 60lb. on the square inch, and had been proved before leaving the maker's yard up to 120lb. by hydraulic pressure. The flat plate at the back of the boiler was flanged at its entire circumference for attachment to the shell, and consisted of two pieces joined together by a seam of rivets running in a horizontal direction, as nearly as may be through the centre of the circle, the plate being half an inch thick, and strengthened with copper stays seven-eigths of an inch in diameter, about 5 or 6 inches long, screwed throughout, and spaced about 12in. apart from centre to centre, which, passing through the water space between the flame chamber and shell of the boiler, were screwed through the two plates and rivetted over at the ends, just as in the flat sides of a locomotive fire-box.

It was at this end plate that the boiler gave way, tearing round its entire circumference through the root of the flanging, drawing one of the copper stays through the plate, and pulling the others asunder; while, in addition, the plate divided at the longitudinal seams of rivets.

Two causes combined to produce this explosion: one, undue pressure of steam; the other, weakness of the boiler. The undue pressure of the steam was due to the defective condition of the safety-valve, which was of lever construction, held down by a Salter's spring balance. I am not able to speak of the condition of the safety-valve from a personal examination, since it had been taken to pieces before I saw it; but the captain of the yacht stated at the inquest that the engineer was in the habit of raising the lever of the safety-valve by hand, because it used to stick, and that he had done this about five minutes before the explosion; while a master boiler-maker, who made an official investigation at the order of the coroner, reported that he did not find the valve in free working order; and this was corroborated by the maker of the boiler, who examined it but half an hour after the explosion had occurred. It was a serious defect in the equipment of this boiler that there was but one safety-valve, whereas there should always be a duplicate. A Select Committee of the House of Commons, appointed in the year 1817, to consider the best means for preventing the explosion of boilers on board steam-vessels, recommended "that every such boiler should be provided with two sufficient safety-valves;" while this recommendation was repeated in America, in the year 1836, by a committee of the Franklin Institute, "appointed to examine into the causes of the explosions of boilers used on board steamboats," and the Board of Trade now enforce that no British steam-vessel shall carry passengers unless this condition be complied with. Had the boiler under consideration been on board a passenger vessel, instead of a gentleman's pleasure yacht, it would not have been allowed to put to sea equipped as it was with but one safety-valve. The other cause of the explosion—viz., the weakness of the boiler—was due to the insufficient staying of the flat end plate. These stays being spaced 12in. apart would, with steam at a pressure of 60lb. on the square inch, be subjected to a strain of nearly 4 tons each, which—since they were made of copper, and only seven-eighths of an inch in diameter at the outside of the thread—was dangerously near to their ultimate strength, and allowed but little margin either for indirect strains being thrown upon them through the working of the boiler or for flaws in the metal; so that to rend these stays asunder there was required but a slight addition to the ordinary working pressure of the steam, and this appears to have been produced by the sticking of the safety-valve referred to above. These stays should either have been more numerous or larger in diameter; but as it was they were insufficient, and the explosion is attributed to the combined defects in the equipment and construction of the boiler.

No. 45 Explosion has excited considerable interest, from the fact of its having occurred at one of Her Majesty's dockyards. It took place at about half-past seven on the morning of Friday, September 7th, and resulted in the death of two persons, as well as in injury to three others.

I visited the scene of the catastrophe a few days after the explosion had occurred, and received every assistance from the authorities of the dockyard in making my examination. I am the more desirous to acknowledge the courtesy I received from these gentlemen since I find myself compelled to take a very different view of the cause of the explosion than that which I understood they entertained themselves.

The boiler, which was not under the inspection of this Association, was the left hand one of two set side by side, both of the Lancashire type, with two cylindrical furnace tubes running through them from end to end, their length being 21ft., and their diameter 7ft. 4in. in the shell, and 2ft. 9in. in the internal tubes, while the thickness of the plates was three-eighths of an inch in the former, and seven-sixteenths in the latter. The boilers were set upon side walls, and each of them had two open lever safety-valves, $4\frac{1}{2}$in. in diameter, loaded by a weight to a pressure of about 55lb. per square inch. From this it will be seen that the boiler was of a safe class, and not worked at an excessive pressure.

The manner in which the boiler was rent was somewhat complicated, and resulted in its entire destruction. It was separated into four main fragments, the furnace tubes, although not rent themselves, being torn away from the remainder of the boiler, along with the back end plate to which they remained attached; while the cylindrical portion of the shell was divided into three irregular belts, two of which were opened out nearly flat. The primary rent appears to have been a longitudinal one, about 4ft. 6in. in length, and to have occurred at the bottom of the shell, and at the back end, a little to the right hand of the centre or keel line, and close to one of the side walls on which the boiler was seated. This primary longitudinal rent, after running across two widths of plate, assumed a circumferential direction, and extended completely round the shell in an irregular and jagged line, passing in many places through the solid metal, and starting in its course other rents, which resulted in dividing the boiler into the fragments already described. All of these were thrown from their original position, and the twin boiler alongside blown from its seat.

At the inquiry into the cause of the explosion, conducted before the coroner, evidence was given by three scientific witnesses, as well as by two

boiler-makers engaged at the dockyard, all of whom unanimously attributed the explosion to shortness of water, supposing that the engine-man had neglected his duty, and allowed the water-supply in the boiler to run short, and then suddenly re-admitted it, when an excessive and uncontrollable pressure of steam had been generated, which burst the boiler. In consequence of this evidence, the jury concluded that "the deaths of the deceased were caused by the accidental explosion of a boiler, and that such explosion resulted from an insufficient supply of water in the said boiler." Thus the *onus* of the explosion was thrown upon the engine-man who had been killed.

My own examination led to a different result. Had shortness of water occurred with steam at the pressure at which this boiler was worked, viz., 55lb., the furnace crowns would certainly have bulged down, and in a short time have rent, whereas they still retain their original shape uninjured, and are covered with a slight cake of incrustation, while the seams of rivets are not opened. The general character of the explosion was altogether different from those which occur to this class of boiler from shortness of water. In this the shell was rent and not the furnace tubes, in those the furnace tubes are rent and not the shell. It is true that the left hand furnace tube was somewhat bulged down; a fact to which much importance was attached at the coroner's inquest, but this depression is clearly the effect of a blow from some portions of the building falling upon it, and not of overheating. It is situated some feet behind the firebridge, and thus not at the hottest part of the tube; in addition to which it is not directly on the crown, but a little on one side, while the entire tube is slightly bent laterally from end to end, the result evidently of a blow of considerable force. It may also be mentioned that the bottom of the tube is bulged upwards, which could not possibly be due to overheating, but is an illustration of the violence the tube had been subjected to subsequent to the explosion. These indentations, therefore, are regarded purely as effects of the explosion, and not as in any way connected with its cause. The consideration of these facts clearly shows that the explosion could not have been due to shortness of water, so that the cause must be sought for elsewhere.

On examining the fragments of the shell, I found that the plates at the bottom of the boiler at the back end, which was the part at which the primary rent occurred, were seriously wasted away by external corrosion, and it is to the thinning of the plates from this cause that I attribute the explosion. This corrosion was so apparent that the thin plates must have been discovered in time to prevent the explosion on a competent and faithful flue examination being made. Yet, one of the boiler makers who gave evidence at the inquest, and occupied the post of superintendent, his duty being to repair the boilers and inspect them when cleaned out, had carefully examined the exploded boiler but seven weeks before it burst, when he reported that it was in a good working state; while another boiler maker—also witness at the inquest—who had repaired it two years ago, was satisfied from the appearance of the exploded boiler, that it was quite fit to do its duty at the moment it burst. Boiler makers clearly do not make good boiler inspectors. They may be perfectly competent to wield a hammer and make a steam-tight seam of rivets, but know little about the principles of boiler construction or the power of steam. Nothing can show more forcibly the necessity of independent periodical inspection by men trained for the special work and accustomed to it by daily practice.

In conclusion, this explosion was not due to shortness of water, through the neglect of the engineman, who was the victim of the disaster and not its cause, but was attributable to the weakened condition of the boiler through thinning of the plates by external corrosion, which might, by competent inspection, have been detected in time to have prevented the explosion.

THE SINGER SEWING MACHINES.

Our attention has been called to the very great improvements which this extensive manufacturing company have made in the construction of this now indispensable domestic requisite. They have now almost entirely dispensed with the complicated machinery in sewing mechanism, the truth of which is demonstrated by an inspection of their newly-invented noiseless family machine, which is a marvel of simplicity and mechanical perfection. Its action is most silent, rapid, pleasing, and perfect for every class of family work. This novel machine is made to work with a straight needle unlike most other machines, and on the lock-stitch principle, which is considered by the most eminent engineers and practical mechanics, as also by those who use them, to be the very best for all utilitarian purposes. The company have also applied to the machines made by them several little ingenious inventions, by which binding, marking, hemming, cording, braiding, trimming, &c., can be rapidly and elegantly done. In reference to the *marker*, we may specially remark that it is a most useful and novel invention for the forming of tucks while in the act of sewing, and being protected by two distinct patents, can only be had with this machine. Then we have a perfectly new invention called the button-hole machine, which has been so constructed that it easily and perfectly makes button-holes. Not later than two years ago a machine for this purpose was said to be utterly impossible of accomplishment, but here we have it a recognised fact and in daily operation in several large establishments in the City. It was exhibited at the recent Workmans' Industrial Exhibition, and may be seen at work at the chief depôt of the company (Cheapside) every day. This machine has been built to supply a want long felt by manufacturers in a very extensive way of business, such as army clothiers, tailors, and mantle makers. We would also call the attention of engineers to the fact that these machines are made for working upon heavy materials, such as leather, canvass, ships' sails, and in fact any substance requiring sewing. The machine is worthy the notice of the scientific mechanic, hence we advert to its *début*.

STATISTICAL SOCIETY.

RAILWAY EXTENSION AND ITS RESULTS.

Read by R. Dudley Baxter, M.A.

The following are extracts from Mr. Baxter's very useful paper :—

1. If a Roman emperor, in the most prosperous age of the empire, had commanded a history to be written of that wonderful system of roads which consolidated the Roman power, and carried her laws and customs to the boundaries of the accessible world, it would have afforded a just subject for national pride. The invention and perfecting of the act of road making, its sagacious adoption by the State, its engineering triumphs, its splendid roads through Italy, through Gaul, through Spain, through Britain, through Germany, through Macedonia, through Asia Minor, through the chief islands of the Mediterranean, and through Northern Africa; all these would have been recounted as proofs of Roman energy and magnificence, and as introducing a new instrument of civilisation, and creating a new epoch in the history of mankind. A similar triumph may fairly be claimed by Great Britain. The Romans were the great road-makers of the ancient world—the English are the great railroad-makers of the modern world. The tramway was an English invention, the locomotive was the production of English genius, and the first railways were constructed and carried to success in England. We have covered with railroads the fairest districts of the United Kingdom, and developed railways in our colonies of Canada and India. But we have done much more than this, we have introduced them into almost every civilised country. Belgian railways were planned by George Stephenson. The great French system was started by Locke, In Holland, in Italy, in Spain, in Portugal, in Norway, in Denmark, in Russia, in Egypt, in Turkey, in Asia Minor, in Algeria, in the West Indies, and in South America Englishmen have led the way in railway enterprise and construction. To this day, wherever an undertaking of more than ordinary difficulty presents itself, the aid is invoked of English engineers, English contractors, English navvies, and English shareholders; and a large portion of the rails with which the line is laid, and the engines and rolling stock with which it is worked, are brought from England. * * *

II.—*Railways in the United Kingdom.*

So far as roads are concerned, the dark ages may be said to have lasted from the evacuation of Britain by the Romans in 448 to the beginning of the last century. During the whole of that period nothing could be more barbarous or impassable than English highways. The Scotch rebellions first drew attention to the necessity for good roads. The first step was to establish turnpikes, with their attendant wagons and stage-coaches; superseding the long string of packhorses which, up to that time had been the principal means of transport. The second step was to render navigable the rivers which passed through the chief seats of industry. The third, which commenced later in the century, was to imitate the rivers by canals, and to construct through the north and centre of England a network of 2,600 miles of water communication, at an outlay of £50,000,000 sterling. But roads and canals combined were insufficient for the trade of Lancashire and Yorkshire, and bitter complaints were made of expense and delay in the transmission of their goods. The desired improvement came from the mining districts. Since the year 1700 it had the custom to use wooden rails for the passage of the trucks. About the year 1800 Mr. Outram, in Derbyshire, laid down iron rails upon stone sleepers, and the roads so constructed took from him the name of Outram's Ways or Tramways. About the year 1814, the ingenuity of mining engineers developed the stationary steam engine into a rude locomotive, capable of drawing heavy loads at the rate of four or five miles an hour. It was proposed to construct a public railway on this principle between Stockton and Darlington. After much delay the line was opened by George Stephenson in 1825, and the experiment was successful as a goods line—unsuccessful, from its slowness, as a passenger line. The next experiment was the Manchester and Liverpool railway projected as a goods line to accommodate the increasing trade of those two places, which was crippled by the high rates of the canal and navigation. Before the railway was completed, another great improvement had taken place in

the construction of locomotives, by the discovery of the multitubular boiler, which immensely increased the volume of steam, and the speed attainable. The opening of the Manchester and Liverpool railway on 15th Sept., 1830, was the formal commencement of the railway era. * * * The Grand Junction railway from Liverpool to Birmingham was passed in 1833. The Eastern Counties railway was sanctioned in 1834. It was launched as a 15 per cent. line. It is said that a wealthy banker in the eastern counties made a will, leaving considerable property to trustees to be expended in parliamentary opposition to railways. The Great Western was thrown out in 1834, but passed in 1835. The London and Southampton. now the London and South Western, was proposed in 1832, but was not sanctioned till 1834. In 1836 came the first railway mania. Up to this time the difficulty had been to pass any bill at all, now competing schemes began to be brought before Parliament. Brighton was fought for by no less than five companies, at a total expenditure of £200,000. The South Eastern obtained its act after a severe contest with the Mid-Kent and Central Kent. Twenty-nine bills were passed by Parliament authorising the construction of 994 miles of railway. * * * In 1845 most of the great lines had proved a success. The London and Birmingham was paying 10 per cent., the Grand Junction, 11 per cent., the Stockton and Darlington, 15 per cent., and railway shares were on an average at 100 per cent. premium. The railway mania broke out with redoubled violence; railways appeared an El Dorado. The number of miles sanctioned by Parliament in the three following sessions was—

	Miles.
1845	2,700
1846	4,538
1847	1,354
Total	8,592

* * But towards the end of 1858 the great Companies had exhausted their funds and ardour, and proposed terms of peace. The technical phrase was "that the Companies required rest." Again, it seemed probable that railway extension would be checked. But another state of things arose. Twenty years of railway construction had brought forward many great contractors, who made a business of financing and carrying through lines which they thought profitable. The system had grown up gradually under the wing of the Companies, and it now came to the front, aided by a great improvement in the value of railway property, on which the per-centage of profits to capital expended had gradually risen from 3½ per cent. in 1850 to 4½ in 1860. The Companies also found it their interest to make quiet extensions when required by the traffic of the country. Thus railway construction was continued in the accelerated ratio of more than 500 miles a year. The following table gives a summary of the rate of progress from 1845 to 1865:

United Kingdom.—Miles Constructed.

Year		Miles opened	Average number opened per annum.
1834	about	200	
			133
1840	„	1,200	
			240
1845	„	2,440	
			812
1850	„	6,500	
			367
1855	„	8,335	
			425
1860	„	10,434	
			533
1865	„	13,100	

During the same period the percentage of profit to capital expended was as follows:—

Year	Per cent.
1845	5·48
1850	3·31
1855	3·90
1860	4·39
1865	4·46

The latter table, which is abridged from an annual statement in *Herapath's Journal*, scarcely gives an idea of the gradual manner in which the dividends sank from their highest point in 1845 to their lowest in 1850, and of their equally gradual recovery from 1850 to 1860 and 1865. The main results of the two tables are, first, the close connection between the profit of one period, and the average number of miles constructed in the next five years; and, second, the fact that the construction of railways in the United Kingdom has been steadily increasing since 1865, and is now more than 500 miles per annum. The number of miles authorised by Parliament during the last six years is stated in the *Railway Times* to be as follows:

Year	Miles.
1861	1,332
1862	809
1863	795
1864	1,329
1865	1,996
1866	1,062
	7,323
Average	1,220

Hence the miles authorised by Parliament for the last six years have been double the number constructed; and there must be about 3,500 miles not begun or not completed, a number sufficient to occupy us for fully seven years, at our present rate of construction. Such is a brief summary of the history of railway extension in Great Britain and Ireland. It may be thrown into five periods:

1. The period of experiment, from 1820 to 1830.
2. The period of infancy, from 1830 to 1845.
3. The period of mania, from 1845 to 1848.
4. The period of competition by great companies, from 1848 to 1859.
5. The period of contractors' lines and companies' extensions, from 1859 to 1865.

* * It remains to describe the great systems into which the English railways have been amalgamated. There are in England twelve great companies with more than £14,000,000 each of capital, which in the aggregate comprise nearly seven-eighths of our total mileage and capital. They divide the country into twelve railway kingdoms, generally well defined, but sometimes intermingled in the most intricate manner. They may be classified into the following seven districts:—

	Mls. open.	Cpl. expnded
1. North Western district—		
London & North Western	1,306	£53,210,000
2. Midland district—		
Midland	677	26,103,000
3. North Eastern district—		
Great Northern	422	18,200,000
North Eastern	1,221	41,158,000
4. Mersey to Humber district—		
Lancashire and Yorkshire	403	21,114,000
Man., Shef., and Lincoln	246	14,113,000
5. Eastern district—		
Great Eastern	709	23,574,000
6. South Eastern district—		
South Eastern	319	18,626,000
London, Chatham, and Dover	175	14,768,000
London and Brighton	294	14,561,000
7. South Western district—		
London and South Western	500	16,364,000
Great Western	1,292	47,630,000
Total	7,564	309,421,000

In Scotland there are three great Companies:—

	Mls. open.	Cpl. expnded.
1. South east coast—		
North British	732	17,802,000
2. Central district—		
Caledonian	561	14,797,000
3. South west coast—		
Glasgow and South Western	240	5,603,000
Total	1,542	38,202,000

which include three-fourths of the whole mileage and capital of Scotch railways. In Ireland there are only two large Companies:—

	Mls. open.	Cpl. expnd. £
1. South western district—		
Great Southern and Western	420	5,712,000
2. Midland district—		
Midland Great Western	260	3,625,000
Total	680	9,337,000

which embrace rather more than two-fifths of the capital and mileage. The above figures are taken from *Herapaths Railway Journal*, made up very nearly to the present time. The following table shows the average gross receipts and net profits for three years, for the United Kingdom, and also the dividends paid on ordinary stock in the above great Companies, except the London, Chatham, and Dover:—

Average receipts and dividends per cent.

	1857.	1861.	1865.
Gross receipts	7·87	8·27	8·57
Net profits	4·19	4·30	4·46

Dividends of great Companies—

12 English	4·00	4·45	4·65
3 Scotch	4·55	4·90	5·70
2 Irish	5·00	5·00	3·56
Average dividends	4·51	4·78	4·64

IV.—*Cost of railways in the United Kingdom*

The total capital authorised and expended, up to the end of 1864, is given in the Board of Trade returns as follows:—

Capital Authorised.

Shares	£390,413,000	
Loans	130,109,000	
Total	520,522,000	

Capital Expended.

Debenture capital—		
Stock	£13,049,000	
Mortgages	93,031,000	
		106,080,000
Preference capital	104,647,000	
Ordinary „	214,755,000	
	425,482,000	

Hence the following conclusions:—1. The capital expended is more than half as large as the national debt. 2. The debenture and preference capital, which are practically first and second mortgages of railway property, amounted in 1864, to nearly half the whole capital expended. The preference capital has for some years been steadily increasing, while the ordinary capital has remained almost stationary, and I believe that the returns of 1865 will show that the debenture and preference capital is now more than half the total capital expended. As the old Companies almost always increase their capital by preference stock, I anticipate that in seven or eight days the debenture and preference capital will have risen to two-thirds of the capital expended. * *

V.—*Traffic and Benefit of Railways of the United Kingdom.*

The railway traffic is new and additional traffic. But railways reduced the fares very materially. For instance, the journey from Doncaster to London by mail used to cost £5 inside and £3 outside (exclusive of food), for 156 miles, performed in twenty hours. The railway fares are now 27s. 6d. first class, and 21s. second class for the same distance, performed in four hours. The average fares now paid by first, second, and third passengers are 1⅓d. per mile, against an average of 5d. in the coaching days, being little more than one-fourth of the former amounts. On canals the effect of railway competition was also to lower the rates to one-fourth of the former charges. In consequence, the canal tonnage actually increased, and is now considerably larger than it was before the competition of railways. Hence the railway goods traffic, like its passenger traffic, is entirely a new traffic. The saving in cost is also very great. Goods are carried by rail at an average of 1⅓d. per ton, or 40 per cent. of the old canal rates. * * Next let us examine the saving to the country. Had the railway traffic of 1864 been conveyed by canal and road at the pre-railway rates, it would have cost three times as much. Instead of £36,000,000 it would have cost £108,000,000. Hence there is a saving of £72,000,000 a year, or more than the whole taxation of the United Kingdom. But the real benefit is far beyond even this vast saving. If the traffic had been already in existence, it would have been cheapened to this extent. But it was not previously in existence; it was a new traffic, created by railways, and impossible without railways. To create such traffic, or to furnish the machinery by which alone it could exist, is a far higher merit than to cheapen an existing traffic, and has had far greater influence on the prosperity of the nation. Look at the efforts on commerce. Before 1833 the exports and imports were almost stationary. Since that time they have increased as follows:—

Increase of Exports and Imports.

One year	Total Exports and Imports.	Per Cent. Increase	Per cent. per annum Increase.
1833	85,500,000		
		36	4·
1842	116,000,000		
		47	6·
1850	171,000,000		
		52	10·4
1855	260,000,000		
		44	9·
1860	375,000,000		
		30	6·
1165	490,000,000		

* * The increase of imports and exports was in strict proportion to the development of railways.

* * But it may be said, how do exports and imports depend on the development of the railway system? I answer, because they depend on the goods traffic; and the goods traffic increases visibly with the increase of railway mileage and the perfecting of railway facilities.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

WHO INVENTED THE SCREW PROPELLER?

Sir,—The notorious impartiality and magnanimity of the British nation, let me hope, that you will be so kind, to insert in The Artizan the letter annexed here, which is a true copy of the original. This original and other references, if requested, shall be given by the respectfully undersigned, Henry Ressel, C.E.

Stadt, Postgasse, No. 6, Vienna, October 14th, 1866.

North American Ressel Committee.

55—57, Chatham-street, New York, September 15th, 1866.

To Henry Ressel, Esq., C.E.—Vienna.

Sir,—The undersigned committee begs to draw your attention to a few important facts. There is no doubt as to the paramount importance of the introduction of the screw in steam navigation. The use of the propeller-screw instead of the paddle wheel was the second great resolution in navigation, and only second in importance to the discovery and application of the great moving power of steam itself. The truth of this fact need not be impressed upon Americans, who in the late war reaped the incalculable advantages of the screw over the wheel in the war navy in a measure to make all argumentation about the fact superfluous. This being the case it is really astonishing to find that almost everybody is ignorant of the name of the man to whom by right of priority belongs the honour of having made the first successful application of the screw in steam navigation, and of so far being the author of this great reform. Take ninety-nine out of a hundred persons, even of those interested in the matter, and they will not be able to give you the name of that great benefactor of mankind, they will tell you, that this important historical question of authorship is doubtful.

The undersigned committee has undertaken the task to show to the world, and particularly to the American nation the fact, that the honour of being the author of the invention and of the first *practical application* of the screw in steam navigation belongs to Joseph Ressel, who in 1827 had the *first* propeller steamer, the little craft *la Civetta*, run on the Adriatic; Joseph Ressel, a poor subaltern of the Austrian navy, who, while he lived, shared the inexorable fate of many great inventors and discoverers, that of being neglected, cheated and persecuted, but since his death in 1857 has been acknowledged, honoured and glorified, whose name as the great reformer in steam navigation is now proclaimed by a splendid monument, which Germany erected to his memory, in front of the Polytechnical Institute at Vienna, Austria, and whose claims on priority are now established, on irrefutable evidence, by the greatest scientific institutes and technical authorities of Europe and America—amongst others our national Academy of Sciences at Washington, *propagated* through all the text books and Encyclopædias.

At the example of the old world, we are endeavouring to establish these facts in this country and among the great, liberal and generous nation, which is not less interested in this question of vindicating the merits and fame of one of the prominent benefactors of mankind, than the monarchical governments of Europe, and to do an act of gratitude and *justice* to the man, to whom our century owes so much, *by erecting a monument to his memory in our capital and by providing for a national reward to his family*. On the contrary, we are under the impression, that this republican people ought to stand at the head of this movement for doing justice to the name of a great genius, and reward and honour him, who during his life was cheated by England, not only out of the very acknowledgement of the fact of his merits, but also the pecuniary reward of his ingenious and toilsome labours.

Convinced as we feel, that we shall not in vain appeal to the liberal and generous minds of the Americans, we beg to address you the request:

"To join the subscribed committee as an honorary member of the same, and permit us to avail ourselves of your honourable name as such as well as of your influence in the propagation and promotion of our cause. Your name will be inserted in the album, which contains already the names of so many prominent men of Europe and America, who as honorary members promoted our cause, and the list of which will afterwards be given to publicity, as a paramount token of the respect and gratitude, which our age, unlike many that preceded it, bears to the genius, who labours for the common good of mankind, without regard to national or sectional distinctions."

The North American Ressel Committee.

Fred Kühne President, Dr. Ch. Kessmann, Vice President, Dr. G. Blonde, Secretary.

(L.S.)

Sigismund Alexauder.	Gustavus Levy.	Rudolph Lexow.
Julius Korn.	Oswald Ottendorfer.	Dr. Mannus Prister.
J. Lindheim.	Rev. Dr. Stein.	A. Willman.
J. Hermann Raster.	Henry Zeimer.	W. Jefferson, E.R.N.
A. J. Dittenhoefer.	M. L. Hiller.	E. Edmonds, E.R.N.

[The claim set forth by the "Ressel Committee" will appear novel to most of our readers. The documents and papers designed to substantiate this claim having been submitted to us by our correspondent, we purpose devoting a page to the subject in our next issue.—ED. ARTIZAN.]

REVIEWS AND NOTICES OF NEW BOOKS.

The Theory of Strains in Girders and similar structures. With observations on the application of Theory to Practice, and Tables of Strength and other property of materials. By BINDON B. STONEY, B.A., Mem. Ins. C.E. In 2 vols. Vol. I, with numerous illustrations engraved on wood. London: Longmans, Green, and Co. 1866.

THE author is favourably known to the readers of THE ARTIZAN as a scientific writer upon subjects akin to that of the present work. Mr. Stoney's treatise on the theory of strains in simple and compound structural arrangements of materials is arranged in a simple, clear, yet comprehensive form, admirably suited for the engineer and contractor. The formulæ are simple and such as can be used by practical men. The selection of cases and illustrations is extensive and well chosen. The success of Mr. Stoney's present work is, we feel assured, certain.

The Scientific and Literary Treasury. By SAMUEL MAUNDER, Esq., author of "The Treasury of Knowledge," "Biographical Treasury," &c., &c. New edition. London: Longmans, Green, and Co. 1866.

THE new edition of this most useful and compendious *Vade mecum* has been thoroughly revised, and in great part re-written, with upwards of one thousand new articles by Mr. James Yate Johnson, Cor. M.Z.S. It is imposible to do justice to this admirable work of reference within the usual limits of space in THE ARTIZAN devoted to the notice of new books and new editions of books. but after a very careful inspection of the contents of the new edition of Maunders Scientific and Literary Treasury we are enabled confidently to express an opinion that it is the only comprehensive work of the kind before the public, and that the celebrity long since acquired by the original writer has not only been maintained but greatly extended by the present editor, who has brought the information upon the various subjects contained in the work down to the present day.

The Students Text Book of Electricity. By HENRY M. NOAD, Esq., Ph. D., F.R.S., F.C.S., &c., &c. London: Lockwood and Co. 1866.

THE well-known reputation of the author of the present work, attained during a long career in the field of scientific literature will insure for "The Student's Text-Book of Electricity" a prominent position amongst the standard books of reference upon this important subject. The most recent discoveries in every branch of the science are given by the author in his most lucid style of description, and the admirable classification of the various subjects enables the student to refer to, and find what he seeks with the least possible amount of labour. Mr. Noad's text-book is got up in excellent style.

The Engineers' and Contractors' Office Sheet and Engineering Almanac, for the year 1867. London: Lockwood and Co., Stationers' Hall-court.

A NOVEL idea carried out in a very comprehensive and useful way, combining selections of commercial and scientific matters, readily available for use.

The Practice of The Referees' Courts in Parliament in regard to Engineering Details, Efficiency of Works and Estimates, and Water and Gas Bills, with Claims to Compensation. By J. SHIRESS WILL, Esq., of the Middle Temple, Barrister-at-Law. London: Stevens and Sons, 26, Bell-yard, Lincoln's-inn. 1866.

A CAREFULLY collected and arranged Book of Practice, more particularly suitable for engineers and agents engaged in the Referees' Courts, has been a desideratum. Mr. J. S. Will, of No. 4, Elm-court, Temple, has just completed a very important and highly useful work that fulfills all the existing requirements of the representatives of the various professions who appear in those Courts, or whose occupation necessitates an acquaintance with past decisions and existing precedents and rules of practice. The author has, as we consider, most successfully achieved a very difficult task, and has produced a work of reference, which, unique in its way, deals with difficult, legal, and technical questions in so clear, plain and comprehensive a manner that any engineer or other layman, may readily grasp them, whilst the engineering and other scientific and technical matters, necessarily involved, are in like manner so well chosen and appropriately employed, and their bearing made so clear that any legal (or non-legal) mind, however unpractised, may as readily and thoroughly master them.

Mr. Will has no reason to bespeak an indulgent reception for his labours, they are not simply highly creditable, but masterly; and the hope that he expresses in the preface, "that this work may prove of some assistance to the engineer," is fully justified. An index to the bills cited, in addition to a very copious general index, greatly facilitates reference to the valuable contents.

Open Fishing-Boat Reform. Fish-market Improvements, and the Abolition of the Hawking System with Creels. By H. DEMPSTER, Esq., H.E.I.C.S.

A PAMPHLET treating of several very important subjects affecting the lives, comfort, and general well-being of an important class of our fellow-men and their families, to which subjects too much attention cannot be given, deserving as they are of prompt and serious consideration.

Devout Moments. Expressed in Verse. A selection from Time's Treasure. By LORD KINLOCH. Edinburgh: Edmonston and Douglas. 1866.

A VERY interesting little collection of verses upon sacred subjects. The last piece, a "Christmas Carol," is beautifully and most appropriately rendered.

NOTICES TO CORRESPONDENTS.

MECHANIC.—We recommend the work "Management of Steel," by George Ede, published by Tweedie, 337 Strand, London, it will give you the information you require.

ELECTRO MAGNET.—There are several very good works published on the subject. Send to Spon, Bucklersbury, London, E.C., for their last catalogue of books; you will there find several from which you may select.

D.D.—The Patent Frictional Gearing will answer the purpose.

PRICES CURRENT OF THE LONDON METAL MARKET.

	Nov. 3.			Nov 10.			Nov. 17.			Nov. 24.		
COPPER.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Best, selected, per ton	89	0	0	89	0	0	89	0	0	89	0	0
Tough cake, do.	86	0	0	86	0	0	86	0	0	86	0	0
Copper wire, per lb.	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$	0	0	$11\frac{3}{4}$
„ tubes, do.	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$	0	1	$0\frac{1}{4}$
Sheathing, per ton	91	0	0	91	0	0	91	0	0	91	0	0
Bottoms, do.	96	0	0	96	0	0	96	0	0	96	0	0
IRON.												
Bars, Welsh, in London, per ton	7	2	6	7	0	0	7	0	0	7	0	0
Nail rods, do.	7	10	0	7	10	0	7	10	0	7	10	0
„ Stafford in London, do.	8	7	6	8	7	6	8	7	6	8	7	6
Bars, do.	8	7	6	8	7	6	8	7	6	8	7	6
Hoops, do.	9	5	0	9	7	6	9	7	6	9	7	6
Sheets, single, do.	10	0	0	10	0	0	10	0	0	10	0	0
Pig, No. 1, in Wales, do.	4	5	0	4	5	0	4	5	0	4	5	0
„ in Clyde, do.	2	14	0	2	14	9	2	14	6	2	14	3
LEAD.												
English pig, ord. soft, per ton	20	5	0	20	5	0	20	5	0	20	5	0
„ sheet, do.	21	0	0	21	0	0	21	0	0	21	0	0
„ red lead, do.	23	10	0	23	10	0	23	10	0	23	10	0
„ white, do.	27	0	0	27	0	0	27	0	0	27	0	0
Spanish, do.	19	10	0	19	10	0	19	10	0	19	10	0
BRASS.												
Sheets, per lb.	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$	0	0	$10\frac{1}{4}$
Wire, do.	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$	0	0	$8\frac{3}{4}$
Tubes, do.	0	0	11	0	0	11	0	0	11	0	0	11
FOREIGN STEEL.												
Swedish, in kegs (rolled)	14	0	0	14	0	0	14	0	0	14	0	0
„ (hammered)	16	0	0	16	0	0	16	0	0	16	0	0
English, Spring	19	0	0	19	0	0	19	0	0	19	0	0
Quicksilver, per bottle	7	0	0	7	0	0	6	18	0	6	18	0
TIN PLATES.												
IC Charcoal, 1st qu., per box	1	14	0	1	14	0	1	14	0	1	14	0
IX „ „ „	2	0	0	2	0	0	2	0	0	2	0	0
IC „ 2nd qua., „	1	10	0	1	10	0	1	10	0	1	10	0
IC Coke, per box	1	4	6	1	4	6	1	4	6	1	4	6
IX „ „	1	10	6	1	10	6	1	10	6	1	10	6

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical hearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

John Crossley and Son *v.* Lightowler.—The plaintiffs, the well-known carpet manufacturers at Halifax, sought to restrain the defendants from polluting the waters of the River Hebble by pouring into it the refuse from their dye works. It appeared that the effect of such pollution was to render the water of the river totally unfit to be used by the plaintiffs in certain necessary processes of dyeing, cleansing, and scouring the wool, the lighter shades employed in the plaintiffs' manufacture being most seriously affected. On Nov. 13th, Vice-Chancellor Wood gave judgment. His Honour said that the plaintiffs had substantiated their case, so far as it rested on the fact of the pollution of the water by the defendants; and with regard to the defence that other mills and works higher up the stream had contributed to the pollution, he held that this was no answer in law if the effect of what flowed from the defendants' works could be distinctly traced. The defendant's main defence, however, rested on the question whether or not previous owners of the property or part of the property where these works are carried on had not long ago enjoyed and exercised the right of fouling the stream. It was established that prior to 1839 Messrs. Irving did in fact carry on works which affected the stream more seriously than the defendants' operations, but the Messrs. Irving's works were closed in 1839. In 1840 the plaintiffs established, and have ever since carried on, their manufactory. Between 1839 and 1864, when the defendants set up their works, the plaintiffs were not impeded in any of their processes by the state of the water, but soon after the defendants began operations the injury complained of by the plaintiffs developed itself. It was for the defendants, therefore, to show that during the 25 years which had elapsed since the plaintiffs' business was commenced the right exercised by the Messrs. Irving up to 1839 had not been abandoned. It would be useless to trace the changes of ownership and occupation which took place between 1839 and 1864 as to the premises which the Messrs. Irving had occupied. It will be sufficient to say, that in the judgment of the Vice-Chancellor the right contended for by the defendants had been abandoned, and his honour held that it was not competent for the defendants to set up again after the plaintiffs had by the acquiescence of the predecessors of the defendants been induced to erect works, and incur great expense in the belief that they were acquiring a right to a pure stream. His Honour observed that if the defendants' contention were just, such a right as they claimed might be suffered to lie dormant for 50 or even 100 years, and then enforced against all who had been acquiring inconsistent rights and interests in the meantime. The injunction must be granted, with costs, and an inquiry directed as to amount of damage sustained by the plaintiffs.

The Law of Master and Servant.—The appeal in the case of Wood and another (appellants) *v.* Bowdon (respondent), was, on Nov. 14th, argued before the full Court of Queen's Bench, sitting in banco. The case stated that upon the hearing of the information it was proved by the respondent and found as facts that he is a master builder carrying on business at Stockport, and the appellants the president and secretary of a society known as the Limited Order of Bricklayers. In October last the respondent was erecting certain buildings, when he sent some of his men to a certain place for a ladder. Barron, one of the appellants, was seen to speak to the men, but what he said to them was not known, upon which the men went back to the building, collected their tools, and said they had been stopped from working. Respondent asked why, when he was told he must know that it was on account of his having four apprentices. The men by their agreement were at liberty to leave, and the respondent to discharge them at any time. Respondent afterwards wrote to the secretary of the society, and asked the reason why his men had been taken away from him, saying he had had no notice, and that he wished to know what the society required. Barron, in reply, wrote that at a meeting of the society it was proposed, seconded, and carried unanimously that he would only be allowed to have two apprentices, and not to have a third until the eldest of the two was in the last year of his time. There was also a demand for £18 expenses which the society had incurred in consequence, which must be paid before the men would be allowed to return to their work. The master builders afterwards came to a resolution to discharge the men employed by them until the respondent's men resumed work. The justices being of opinion that an offence had been committed convicted the appellants. The learned counsel contended that the appellants had by threats or intimidation forced or endeavoured to force the respondent to limit the number of his apprentices. The question was, what was the meaning of "threats or intimidation," as used in the clause of the words, Master and Servants' Act, 6th George IV., sec. 129. In delivering judgment on the issue raised by the appellants, the Lord Chief Justice said—"I am of opinion that this conviction must be quashed. It is quite unnecessary to determine in the present case whether the combination of the workmen forming this association, and the resolution they adopted not to work for the respondent unless he reduced the number of his apprentices, would be lawful or not at common law. I quite agree that cases of this kind ought not to be pressed further than they had gone, and we ought, so long as there is nothing in them contrary to law, to leave it open to labour on the one hand and capital on the other to make the best terms they can for themselves. And inasmuch as men have not the advantage of wealth, they cannot very often protect themselves except by means of combinations in associations of this kind, therefore we ought not to strain the law against those who have no other means to assist each other. There may, however, be cases contrary to the common or statute law, but it is not now necessary that we should determine whether this combination is an unlawful one or not. To bring a conviction under this particular act it must be a threat or intimidation to the master, and facts become most important in considering that question. It appears that the appellants are the chairman and secretary of a certain association, and on a given day the appellant Barron was seen in conversation with the respondent's workmen, after which the latter suddenly left their work. No threat was at that time made to the master, but the men having left he inquired of Barron why they had left, and he replied, 'Simply on account of your apprentices.' In that I can find no threat, certainly no joint threat on the part of the appellants. The master then again moves in the matter. There was no spontaneous communication made to him when the resolution was agreed to, to intimidate him by means of a threat to reduce the number of his apprentices; and the respondent when his men left, with the view of ascertaining why the men had been withdrawn from his employment, put himself into communication with the society, evidently for the purpose, if possible, of entering into negociations so as to arrive at a settlement with the society. He asked the reason why his men were withdrawn, and he received a letter written by Barron, at a meeting over which Wood presided, containing a copy of the resolution, for which letter, if it had really amounted to a threat, Wood would have been responsible with Barron as a joint act. It was not for the resolution, or for what was done under it, that the information was laid and the conviction obtained. We must see whether the letter written under such circumstances amounts to a threat. We have nothing to show that although the letter purported to afford explanation by way of answer to the question put by the employer, it was intended to convey a threat. I do not think there is enough to warrant the inference, under the circumstances, that it amounts to a threat under the terms of the act of parliament, and on that ground the conviction cannot be sustained." Justices Mellory, Shee, and Lush concurring, the conviction was quashed.

Importation of Vessels into the United States.—The following, although not belonging strictly to the class of legal but rather administrative decisions, will be found highly interesting by many of our readers; it is taken from an American contemporary:—"An interesting case to ship builders has just been decided by the Secretary of the Treasury. A vessel arrived at Galveston, Texas, having for her cargo the sections of two iron steamers, built in Glasgow, Scotland. The master of the vessel was fined 1,000 dollars for non-conformity with the registry law, and refused admittance for the cargo of his vessel. The Secretary, however, directed that collector to admit the cargo as other merchandise, and also ordered marine papers to be granted the steamer, establishing the precedent of allowing vessels built in foreign Governments the benefit of our registry law.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Area and Population of the United States.—The land and water surface of the United States are equal to 3,250,000 square miles land—land, 3,010,370; water, about 240,000 square miles. The States embrace 1,804,351 square miles of landed surface, and the territories 1,206,019, as exhibited by the eighth census, 1860. The number of inhabitants returned in 1860 was 31,443,321 (states. 31,148,046, and in the territories 295,275), thus showing an average of 17 inhabitants to the square mile in the states, while in the territories 4 square miles to each inhabitant, and exclusive of the District of Columbia, the territorial area would represent 3 1-5 square miles to each inhabitant. In 1860, Massachusetts had 157, Rhode Island 133, New York 82, and Pensylvania 62 inhabitants to the square mile, which rates, applied to the United States, would give 472,400,246, and 189,000,000 of inhabitants, respectively. Belgium, England, Wales, and France in 1855 had 397, 307, and 173 inhabitants to the square miles, respectively. If the United States was densely populated as France, then our population would amount to 528 millions; or England and Wales, 924 millions; and according to Belgian density of population (397 to the square mile) the United States would contain 1,195 millions, which is 110,086,000 more than the entire population of the world in 1866.—*American Paper.*

The New Aberdeen Waterworks.—The quantity of water taken off daily will be 1,350,000 gallons, and of this quantity 350,000 gallons will be pumped up to the high-service reservoir. The remainder serves to give the necessary hydraulic force, equal to about 50 horse-power, for pumping, and is then allowed to run off into the Dee. The quantities of material which have been used in the construction of this, perhaps, the greatest undertaking in which the town of Aberdeen was ever engaged, are as follow:—Of bricks, upwards of seven millions—about 42,000 tons weight—have been consumed, equal to about twelve millions of common bricks, those used being, as we said, considerably above the ordinary size. Of clay puddle the quantity used was about 70,000 tons for the reservoirs and aqueduct, the clay being chiefly obtained from Ruthrieston, Dunn, and Cairntou. For the pipes and other ironwork 2,500 tons of iron were required. The extent of earthwork excavation required for the aqueduct was about 300,000 cubic yards, and of filling in about 170,000 cubic yards. Of rock excavation in the tunnel there were nearly 60,000 cubic yards. The number of men employed on the works varied from 1,000 to 1,500.

Peat as Fuel for Locomotives.—A weekly contemporary says:—When we consider the state of alarm into which Great Britain has been thrown by the predicted speedy exhaustion of her coal fields, it is somewhat startling to find that she possesses sources from whence some 21,000 millions tons of good fuel may be had for little more than the labour of extraction. Great Britain and Ireland are dotted over with peat deposits, which in the aggregate are reported to represent about six million acres. The thickness of these deposits varies in different localities; in some the peat is but 2ft. thick, in others 40ft. or even 50ft.; we will, however. take the average at 12ft. Now, according to the known results of the practical working of peat deposits, an acre yields about 3,500 tons of dried peat. It follows, therefore, that the aggregate estimated average in this country would produce twenty-one thousand million tons of dried peat, which would be equal to the supply of twenty-one million tons per annum for a thousand years. This is the theory, whilst the practice has been to systematically neglect so great a boon as our peat bogs offer to modern civilisation. It is true that in past years occasional attempts have been made, especially in Ireland, to utilise peat for the purposes of fuel, but these have to a great extent failed. It was found that air-dried peat, at the end of several months, still retained a large percentage of moisture, and when machinery was applied to expel the water the cost was so great as to render the manufacture unremunerative. Commercial failure checked for a while all attempts to re-open the question; the last few years, however, have witnessed some highly successful attempts to utilise the yield of our hogs and moors. By removing the coarser roots, and reducing the body of peat to a pulp and afterwards drying it, it becomes converted into a dense mass, and is becoming known by the name of "condensed peat." This peat has formed the subject of numerous interesting experiments, which have all proved its value as a fuel in various branches of the applied sciences. It has been used in locomotives, in steam vessels, in iron and steel furnaces, and even in gas making with uncommonly good results.

The Engineer Surveyorship of the Ports in the British Channel.—The appointment to this office has fallen upon Mr. S. W. Snowden.

Tunnelling.—There seems to be a great rage just at this time for tunnelling rivers

and other water channels. Chicago is advertising for a tunnel with three separate roadways under the Chicago river. A tunnel is also talked of under the Mississippi at St. Louis. The East River, between New York and Brooklyn, and the Straits of Dover, between England and France, have long been a standing problem for engineering skill in this direction, and it is predicted that but a few years will elapse before the locomotive will be thundering its way under the Hudson River to New Jersey. A large amount of scientific labour is now being earnestly brought to bear upon schemes, the conception of of which a few years ago, would have been thought the height of folly.—*Mining and Scientific Press.*—[Our contemporary omits to mention the proposed Mersey tunnel between Liverpool and Birkenhead, the execution of which bids fair to take the precedence of all those here alluded to, and on the success of which the starting of the Long Island and other submarine tunnels will doubtless depend.—Ed. ART.]

MILITARY ENGINEERING.

THE NEW PRUSSIAN BREECH-LOADERS.—Herr von Dreyse, the inventor of the *Zundnadelgewehr*, has completed several new weapons, said to surpass the old ones in many respects. The first is a rifle entirely of iron, with a semi-circular hook where the butt-end ought to be. By the shoulder lifting into this horse-shoe-like termination the aim is considerably steadied, an advantage of no small moment for ordinary shots, especially in the thick of the battle. The barrel has a coating of some composite substance to prevent its scorching the fingers after several discharges. It is 3lb. lighter and 7s. cheaper than the present needle-gun, can be fired eight times in a minute, and in the hands of an experienced marksman hits a man at the distance of a thousand paces. In addition to this one we have another specimen from the hands of the same inventor, looking exactly like the first, only that the barrel is a little more bulky, and the bore proportionably wider. The projectile belonging to this latter gun is said to tell at a distance of 1,500 paces, and, by bursting into eight pieces at the moment of striking, to approach in its effects the deadly execution done by the modern grenade. Ammunition waggons are as easily exploded by it as by shot thrown from a cannon; and as its weight admits of its being carried by men of ordinary strength, it is this rifle to which, in the eyes of the originator, ought to be accorded the palm. The internal mechanism of both new rifles is that of the needle-gun in an improved form. One of the improvements introduced is the rapid retreat of the needle after piercing the *Zundspiegel* and igniting the cartridge, which not only adds to the celerity of the discharge, but also protects the needle from being burnt. It is the practice now to supply every soldier with a couple of needles. A still more remarkable instrument constructed on the breech-loading system, has simultaneously with the above, left the famous worshop of Sommerda. This a breech-loading, double-barrelled cannon, with the ammunition chest inserted between the two tubes, and semi-circular hooks, such as before described, fixed at the end. No more than one man is needed to work each barrel, the ammunition being propelled towards the gunner by a simple process, and falling into its allotted place directly the valve is removed. Each barrel fires off an average four shots a minute, the two altogether accordingly discharging eight in that space of time. Dreyse has constructed several specimens of different calibre, corresponding to the 3-pounders and 6-pounders of the Prussian service. A conical projectile shot from the heavier sort was seen to penetrate an iron plate 2in. thick, and ignite the wooden frame behind, at 2,000 paces. The few models extant of these productions are in the hands of the Berlin War Office, undergoing the strictest scrutiny by a special commission of artillery and other officers.

THE CHASSEPOT BREECH-LOADER.—On this new rifle, which is likely to be adopted throughout the French army, a correspondent of the *Times* supplies the following information :—This gun is the invention of M. Antoine Alphonse Chassepot, Head Viewer of Military Arms in Paris. It is a modification of the Prussian needle-gun; the action is the same throughout in principle, but greatly improved in detail. The result is an arm in every respect superior. The opening of the breech is effected, as in the needle-gun, by a plunger, drawn backward and forwards within the cavity of the breech by means of a lever projecting from it, which engages in a notch prepared to receive it when ready for use. In the Prussian gun no special provision is made to prevent the escape of gas past the plunger; this in the Chassepot is accomplished by a triple wad of vulcanised india-rubber placed round the axis of the plunger, behind a steel plate which forms the front of the plunger, and which has a free motion backwards. This plate is driven back by the force of the explosion upon the india-rubber pressing it out so as to fill up the barrel, thus rendering it gas-tight. Of the three wads forming this cushion, the centre one is more elastic than the upper and lower, but all are harder than ordinary vulcanised india-rubber. The three wads together are about 7-16ths of an inch thick. The gun is fired by a sharp-pointed steel needle, driven by a coiled spring of wire passing through the centre of the plunger. The cocking is effected, as in the Prussian gun, by drawing back the tube containing the needle, but the arrangement is much simplified, and by means of notches ingeniously contrived it can be placed at half-cock. The cartridge exhibits an important modification of that of the Prussian gun. In the latter the fulminate is placed at the base of a papier-mache wad on which the bullet rests; the needle, consequently, has to penetrate through the powder before exploding the charge; this exposure to the flash soon injures the needle. In the Chassepot gun the fulminate is at the base of the cartridge, as in the English Boxer cartridge; but in other respects the arrangement is materially different from the Boxer. The fulminate is placed in a flanged copper cap of small size, having two holes at the bottom to permit the passage of the flame to the powder. The cap is placed with its mouth towards the needle, in a paper wad, in the centre of which is a hole of a suitable size for its reception. The flange of the cap resting on the wad gives the necessary resistance to the blow of the needle. This wad forms the bottom of the cartridge. A thin piece of paper covers the end of the cartridge and the mouth of the cap; the needle has only to penetrate the paper before entering the cap. The weight of the bullet is 386 grains, charge of powder 55 grains, the total length of cartridge $2\frac{5}{8}$ inches. The diameter of the cartridge is 3-16ths of an inch larger than the bore of the barrel, the latter being ·432in., or less than 7-16ths of an inch. The breech end of the barrel for the length of about $3\frac{1}{2}$in. is opened wider than the bore, tapering by steps from $\frac{5}{8}$ of an inch at the face of the plunger to the size of the bore, ·432in. Projecting from the face of the plunger is a tube 5-16ths of an inch outside diameter and about three-eighths of an inch long, through which the needle passes. The base of the cartridge when in the chamber rests against the end of this tube; between the cartridge and the face of the plunger there is, therefore, an empty space round the projecting tube. The object of this space is to effect the combustion and removal of any portion of the cartridge case that may remain after firing. The wad containing the cap must necessarily remain, and requires removal before the next cartridge can be inserted. The weight of the gun without the bayonet is 8lb. 15oz.; the total length, 51in. The bore of the barrel is ·432in. It is rifled with four grooves having one turn in $21\frac{1}{2}$in. We have here a close approximation to the system of Mr. Whitworth, whose bore, as is well known, is ·451in. the grooves having a turn in 20in. The system is not applicable to the conversion of existing guns, and as it is a difficult and costly gun to make, it must be a work of time to obtain the necessary supply for arming the French forces. We have expressed the opinion that this arm is throughout its details in every way superior to the model from which it is imitated, the Prussian needle-gun. When compared with the Snider gun, adopted for the English service, it is behind it in simplicity, rapidity, and freedom from liability to derangement. Its light bullet and small charge cannot equal in range and execution the 530 grain bullet, propelled by 70 grains of powder, of the Boxer cartridge; nor is the cartridge impervious to wet, like the Boxer, which is found to be effective even after being steeped in water for a length of time. On the other hand, this lighter charge enables the French soldier to carry 90 cartridges, weighing no more than the Englishman's 60. This is a point that may well deserve the consideration of our authorities of the War-office.

BREECH-LOADERS IN AUSTRIA.—The Vienna military journal *Der Kamerad* publishes an article on breech-loading rifles, from which the following passages are extracted :—"We learn that besides the Remington, experiments have lately been made with the Peabody gun, as well as a new system by Lindner. The Remington fires 16 shots a minute, the Lindner 14, and the Peabody 15 or 16. The Remington costs 30 florins, and the Lindner 25 (1 florin = 2s.) For the Remington and Peabody copper cartridges are required, costing three kreutzers and a half each ($3\frac{1}{2}$ farthings); the Lindner can be used either with those of copper or paper, the latter costing four kreutzer (the envelope alone, not including the charge). Of the three systems that of Lindner is the only one that would admit of application to the guns at present in use, and that transformation would cost about five florins and a half per gun. Austria possesses 1,200,000 muskets, of which 180,000 are new and have never been used, and 400,000 more are in a very good state. According to the prices mentioned above, the acquisition of 1,000,000 Peabodies would cost 32 millions of florins, of Remington's 30, and of Lindner's 32. If the existing ones are to be transformed (and otherwise they are valueless), that can only be done by the Lindner system; the two others are not practicable, and the transformation of the 480,000 still serviceable would amount to 2,640,000 florins." Herr Lindner, is, we understand, an Austrian by birth, but has been for many years a resident in the United States

RAILWAY ACCIDENTS.

It is our painful duty to record again several railway accidents, three of which occurred on one and the same day (Nov. 12th). Although one of these accidents only occasioned actual destruction of life, the serious jeopardy into which the frequent occurrence of such disasters places life, health, and property of a large section of the community, cannot be pointed out and dwelt upon too often. In France and Belgium railway collisions are very scarce; in Germany and Italy they are seldom heard of. In all these countries a serious and extensive supervision on the part of the public authorities acts as a wholesome check on the carelessness and negligence of companies and their servants. We should be very sorry to see government interference introduced in this country to the same extent as it exists in most parts of the Continent; yet, its total absence (except *post factum*), is almost more objectionable than the system practised abroad. In our opinion, it is the duty of the authorities not merely to enquire into the causes that *have led* to loss of life, but also by an efficient control to wholly or partially prevent those that *may lead* to such disasters. Some action of the legislature in this matter is most urgently called for.

A RAILWAY COLLISION took place on the London and North-Western Railway, near Preston, on November 8th. Shortly after five o'clock, p.m., a cattle train from Carlisle to Liverpool left Preston station, and in its rear was a tank engine, which had been sent to assist it up an incline. When the train had proceeded several hundred yards from the station a goods train from Liverpool to Scotland came in sight, and about the same time another engine, which had been standing on a siding, moved on the main line, but not being able to get clear in time, it came in violent collision with the Liverpool goods train and knocked it against the tank engine on the other line, so that the whole three were literally jammed together. The drivers and stokers escaped almost miraculously. The van attached to the cattle train, containing the breaks-man and a number of cattle-dealers, was also completely thrown off the line, and was driven on end at the top of a steep embankment. The greatest confusion ensued, but the breaksman and the cattle dealers got out of the van as best they could, and though much shaken and considerably alarmed they did not seem to have sustained any serious injury. One or two waggons in front of the van were also thrown off the line. The tank engine and that of the goods train from Liverpool were driven against each other with terrific force, and were completely wedged together, the sides being smashed, and the cylinder and other parts were broken to pieces. Some damage was also done to the other engine.

FATAL ACCIDENT ON THE NORTH BRITISH RAILWAY.—A serious accident occurred on the North British Railway, about a mile and a half east of Longniddry Station, whereby one passenger was killed and several injured. The accident occurred to the train which leaves Dunbar at 2.55 p.m., and is due at Edinburgh at 4.20. It is a slow train, stopping at all the stations between Dunbar and Edinburgh; and at the time the accident happened it was proceeding at the rate of from 20 to 25 miles an hour. The train consisted of three waggons following the engine, five carriages, and a guard's brake van. When near Spittal siding, about midway between Drem and Longniddry, the tire of one of the wheels of the waggons nearest the engine flew off. The train had proceeded several hundred yards after this when the engine, with three waggons attached, separated from the rear part of the train, which then ran off the line. The carriage next the trucks was a second class one, which became uncoupled, and it was struck by the carriages following and knocked over. The next carriage was a first class, which ran off the line into the field, but it remained on its wheels. The passengers in the second class carriage were the most unfortunate. Among them, Mrs. Arrowsmith, of Prestonpans, the wife of an officer in the army, was killed on the spot. The tire which flew off has been examined, and found to have been only a few months in use, and that it was made of the best material. Only a very small portion of the rails were torn up.

MINES, METALLURGY, &c.

PROCESS FOR TREATING COPPER ORES.—A correspondent writes to the San Francisco *Mining Press*:—"The greatest objection to the various methods of extracting copper from its ores by solution, is the great cost of iron for the precipitation, as a quantity is consumed nearly equal to the copper obtained. I have devised a process applicable to poor pyritous ores, of which there is an abundance in this country, by which this difficulty is obviated, and which, I think, possesses some other advantages over those in use. It is substantially as follows: Crush the well cleaned ore through a screen of about thirty holes to the inch; roast in a reverberatory furnace, at a low heat, so as to produce the greatest possible quantity of sulphates; leach the roasted ore with solution of chloride of lime; the result will be a solution of chlorides of copper and iron, sulphate of lime remaining with the ore; oxide of copper will be dissolved by the action of the chloride of iron. The ore will probably still retain some copper; it must be re-roasted, this time dead, so as to convert all the copper present into oxide, and bleached with the solution previously obtained, which must contain sufficient chloride of iron for the purpose. A deficiency of the latter may be remedied by means of common copperas treated with chloride of lime. If well managed, a nearly pure solution of chloride of copper will be obtained, which must be treated with milk of lime, by which the copper will be precipitated as oxide, and the resulting solution of chloride of lime will be ready for another operation. Variations of this process will readily suggest themselves. In some cases it may be best to roast the ore dead the first time, and treat it with chloride of iron produced from the sulphate by chloride of lime; or, after roasting dead, a quantity of crude pyrites may be added to the still hot ore, when sulphates will be formed in great abundance. If the sulphate of lime was marketable, it would be easy to obtain it separate from the ore. Poor ores of the oxides of copper should be mixed with pyrites and roasted, by which any calcareous matter will be converted into sulphate. Where wood abounds close to the mine, I think ores of the class named might be economically worked in this way.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of The Artizan."

Dated October 12th, 1866.

2643 J. Patterson — Mills for grinding, crushing, splitting, and hulling or shelling grain and other substances
2644 J. Pollard, T. Whitehead, J. Whitehead, and V. Williamson—Machinery for combing wool and other fibrous substances
2645 E. Beanes—Refining or decolorising sugar and syrup
2646 J. E. Buerk—Detecting apparatus for registering the time of watchmen and others
2647 W. Clark—Warming rooms and apparatus for the same

Dated October 13th, 1866.

2648 T. Sagar and T. Richmond—Looms for weaving
2649 L. R. Bodmer—Cleaning and carding wool and other fibrous substances
2650 L. R. Bodmer—Application of enamel to certain friction surfaces of looms for weaving
2651 T. Greenwood—Manufacture of trenail
2652 A. Albini and F. A. Braendlin—Breech loading firearms
2653 E. M. Boxer—Cartridges for breech loading firearms
2654 W. Rossetter—Looms for weaving
2655 S. Collins—Tires for carriage wheels
2656 J. Dale and J. G. Dale—Sulphuring yarns and fabrics
2657 W. L. Wrey—Construction of ships and vessels with a view to speed and buoyancy
2658 F. Meyer, W. Wainwright, and T. P. Pascoe—Candles, and moulds employed in the manufacture

Dated October 15th, 1866.

2659 G. Lake—Sizing cotton warps
2660 J. Giles—Manufacture of certain description of nails, tacks, and pins
2661 S. Holness—Means of rotating brushes or other articles for which a revolving motion is required
2662 J. Wright—Ornamenting headsteads
2663 E. Stevens—Forks, steels and knife sharpeners
2664 D. Gilson—Ironing fabrics
2665 P. H. Newman—Manufacture of coloured glass
2666 W. R. Lake—Tapping beer casks

Dated October 16th, 1866.

2667 J. Griffiths—Furnaces, and constructing and actuating the moveable fire bars of furnaces
2668 J. Blain—Finishing yarns and threads used for weaving and sewing purposes
2669 G. T. Bousfield—Manufacture of green and blue colouring matters
2670 W. H. P. Gure—Hansom cabs
2671 A. Swan—Recovering lees
2672 J. Smith and J. J. Rowe—Taps for regulating the flow of fluids
2673 A. V. Newton—Steam boilers
2674 A. V. Newton—Manufacture of reflectors
2675 T. Woodward—Elevating sewage, water, and other liquid matters
2676 R. Napier—Building ships and vessels of war

Dated October 17th, 1866.

2677 J. G. Tongue—Stamps, hammers, and apparatus connected therewith, actuated by steam, &c.
2678 W Harvey—New stage carriage
2679 J. Bronner —Fixing of draught apparatuses and their respective supports on all kinds of gas burners, &c.
2680 H. Kessler—Self acting lubricator for the cylinders and slide boxes of locomotives and other steam engines
2681 J. Slessor—Distilling alcoholic spirits
2682 R. L. Hattersley and J. Smith—Working the healds employed in looms for weaving
2683 J. Hamilton—Improved fuel
2684 J. Coates—Packing for piston valve, pump, or other such rods or spindles
2685 A. V. Newton—Distilling petroleum and other oils
2686 C. A. Girard—Manufacture of blue colouring matter
2687 G. Haseltine — Preventing, indicating, and correcting an undue degree of superheating of steam in steam boilers

Dated October 18th, 1866.

2688 J. Miller—Washing cloth and clothes
2689 W. Manwaring—Reaping and mowing machines
2690 B. G. George—Show cards, bills, or tablets for advertising purposes
2691 A. R. F. N. Darbel—Caustic soda
2692 C. Chapman—Construction of ships for war purposes
2693 W. E. Gedge—Jacquard looms
2694 R. Furnival—Braiding machines
2695 M. A. F. Mennons—Breech loading firearms and cartridges for the same
2696 N. Grew and H. Money—Separating liquid from solid substances
2697 W. Eades and W. T. Eades—Bearings for shafts and axles
2698 W. Simpson—Machinery for preparing and treating vegetable fibres to be used as half stuff in the manufacture of paper
2699 J. Hesken—Packing pistons and stuffing boxes
2700 C. E. Brooman—Apparatus for holding petroleum and other inflammable liquids

Dated October 19th, 1866.

2701 F. Ockerby — Improvements for a Hansom cab
2702 J. C. Brentnall and R. Edge—Spinning and doubling
2703 J Haworth—Coverings for the head
2704 G. Davies—Type setting machine
2705 E. W. Ureu—Dressing granite and all other kinds of stone
2706 C. E. Brooman—Pins, nails, or tacks
2707 E. L. Simpson—Preparation of india rubber and kindred gums
2708 C. Jones—Coal mining machinery
2709 A. Parkes—Manufacture of parkesine or compounds of pyroxylin, and production of imitations of ivory and pearl
2710 E. B Bigelow—Power looms
2711 T. Restell—Breech loading firearms, and cartridges for the same

Dated October 20th, 1866.

2712 J. H. Kidd and J. C. Mather—Floor, leather, brattice, oil, and other cloths, and their manufacture
2713 G. W. Dyson—Metal chains
2714 O. L. Hopson and H. P. Brooks—Pointing wires to form pins, &c.
2715 G. Dixon — Fringes, tassels, and such like upholsterer's trimmings
2716 W. Clark—Electric telegraph apparatus
2717 T. Horby—Stamping machines
2718 G. Haseltine—Sewing machinery

Dated October 22nd, 1866.

2719 F. Petitdidier—Applying designs in relief and brilliancy to all kinds of fabrics
2720 J. G. Tongue—Construction and arrangement of steam boilers and means for collecting sediment therein
2721 J. Day—Vehicles for the conveyance of passengers
2722 T. Booth—Receptacle for containing articles whereby the same are caused to retain their heat
2723 A. C. Kirk—Steam dredgers
2724 J. H. Johnson—Propelling and steering ships and vessels
2725 A. V. Newton—Salinometer pot
2726 A. V. Newton—Fastening for baling bands
2727 S. Peddar—Lifting cut crops

Dated October 23rd, 1866.

2728 J. H. Johnson—Making paper
2729 R. T. Williams—Markers' butt or mantlet, and danger flag and signals for rifle shooting
2730 J. J. Lane—Making wax tapers, &c., and cutting same into lengths
2731 J. Richards—Manufacture of certain parts of brooches, &c.
2732 A. Field—Manufacture of candles
2733 J. Greenshields—Making gas and coke
2734 R. Hollingdrake—Metallic pipes for heating buildings and extinguishing fires therein
2735 A. V. Newton—Rails for railways
2736 G. Wethered—Washing clay and other earthy matters
2737 G. Haseltine—Ovens
2738 W. Harrison—Consuming smoke in furnaces
2739 W. R. Lake—Cartridges and manufacturing the same
2740 G. Haseltine—Sewing machinery

Dated October 24th, 1866.

2741 J. Ogden—Metallic packings for piston rods and other purposes
2742 E. Mignot — Distending the lower parts of ladies' dresses or petticoats
2743 T. Wilson—Breech loading firearms and cartridges for the same
2744 J. Watts—Furnaces and fire places
2745 H. D. Plimsoll, J. B. Davies, and W. D. Dawson—Extracting metals from titaniferous iron sand or minerals containing metals
2746 C. E. Brooman—Combing wool and other fibres
2747 Sir E. F. Piers—Working railway signals
2748 H. S. Colemnu and A. G. E. Morton—Reducing oil cake
2749 J. C. Stevenson—Furnaces for the manufacture of alkali
2750 F. Taylor—Receiving, drying, and deodorising human excrement

Dated October 25th, 1866.

2751 W. Calvert—Wearing apparel
2752 W. Denton, J. Whitaker, and E. Brook—Signalling apparatus for use on railways
2753 J. L. Davies—Cotton gins
2754 B. J. B. Mills—Manufacture of ploughs
2755 C. E. Brooman—Apparatus for lighting and heating
2756 H. Phillips—Preparation of deodorising materials and manufacture of gas
2757 J W. Roberton—Breech loading firearms
2758 D. McDermid—Parting wall papers
2759 G. T. Bousfield—Manufacture of gases for producing heat and the application thereof to metallurgical operations
2760 W. Macdonnell—Fastening the mouths of corn flour and other sacks

Dated October 26th, 1866.

2761 J. P. Débauché—Cylindric brush for waxing apartments
2762 P. A. Muntz—Metal tubes
2763 J. Storer—Lubricators
2764 J. Fisher—Moulds for casting metals
2765 C. D. Abel—Percussion spinning top
2766 A Manuel—Uncorking bottles
2767 G. F. L. Meakin—Method of capping old and new rails used on railways and other ways
2768 W. Weldon—Decomposing chloride of sodium and other compounds by means of steam
2769 M. H. Loomis—Improvements in lamps
2770 N. H. Loomis—Machines for composing and printing
2771 J. H. Gresham—Safety fuzes, and means employed therein
2772 A. Turner—Taking up apparatus, applicable to machinery for the manufacture of elastic fabrics
2773 J. Wagener and G. J. Firmin—Sugar refining
2774 F. Crossley — Machinery for separating the fibre of flax or other vegetable substances requiring such treatment
2775 L. Latter—Brakes for carriages
2776 T. S. Simpson—Ships' boats

Dated October 27th, 1866

2777 B. Tucski—Hats of all kinds
2778 E. Howard—Securing perfect immunity from danger in the use of paraffin and other lamps liable hitherto to explode
2779 J. Sharp and R. Smith—Explosive compound
2780 G. Davies—Rivetting press for securing buttons to fabrics
2781 G. A. Huddart—Buttons and attachment of buttons to garments and fabrics
2782 C. Tiffin—Construction of perambulators, &c.
2783 J. Blackman and E. Blackman—Medicine for the cure of hooping and other coughs
2784 W. R. Barnes—Fire escapes

Dated October 29th, 1866.

2785 M. Hopkins and A. D. Hopkins—Sewing machines
2786 F. Tubino—Lockets
2787 J. Gee—Ventilation of hats, &c.
2788 C. McBeath—Treatment of shale coal and other bituminous substances, and the means employed therefor
2789 J. E. Ward—Hats for the head
2790 J. H. Johnson—Metallic band fastener
2791 J. H. Johnson—Preparation of iodide of ethyl and other organic matters
2792 R. H. Tweddell—Hydraulic presses, &c.
2793 E. Alexandre—Construction of organs
2794 S. Faulkner—Carding engines, and grinding the rollers thereof

Dated October 28th, 1866.

2795 J. Thorpe—Manufacture of oil haizes, &c.
2796 P. Adie—Clipping horses and other animals
2797 J. Hunter — Machinery for excavating and mining
2798 J. H. Johnson—Treatment and preservation of grain, &c., and means employed therein
2799 H. Wedekind — Grinding and reducing dry substances, and the means employed therein
2800 H. Churchman—Cleaning boots and shoes
2801 G. Dacre—Lathes
2802 J. Varley—Feeding water to steam boilers
2803 C. H Gardner — Lithographic, zincographic, and typographic printing machines
2804 J. Wilkinson—Apparatus to be used in connection with milling machinery
2805 W. E. Newton—Steam boilers
2806 A. V. Newton—Spinning, doubling, and twisting wool and other fibrous materials
2807 A. Fairbairn, T. S. Kennedy, and J. W. Naylor — Covering metal rollers used in the manufacture of flax, &c., with leather
2808 H. M. Nicholls—Cutting continuous paper into sheets
2809 M. P. W. Boulton—Employing the motive power of jets of fluid
2810 G. T. Bousfield—Treating sheet iron plates
2811 L. Daggett—Boots and shoes
2812 F. Brown—Brushes
2813 G. H. Dow and P. M. Parsons—Breech loading firearms, and manufacture of cartridges and apparatus employed therein

Dated October 31st, 1866.

2814 W. Robertson—Self acting mules
2815 J. Dodd—Self acting mules
2816 J. Scott—Raising and lowering weights
2817 T. Welton—Metallic brush
2818 J. Scott—Pneumatic signal means for giving alarms in case of fire
2819 W. Clay and A Bowater—Utilising Bessemer and other steel and iron scrap
2820 J. Keighley—Looms for weaving
2821 H. A. Williams—Fastenings and backing for armour plates
2822 R. Holden—Looms for weaving
2823 W. Clark—Lamp glasses
2824 W. E. Newton—Vacuum air engine
2825 J. H. Shorthouse and J. Ferguson—Recovering tin from waste scrap tinned iron by the use of pickle
2826 J. Patterson—Fastening screw bolts and nuts when tightened up.
2827 J. J. Holden and S. J. Best—Doors of gas retorts

Dated November 1st, 1866.

2828 J. H. Johnson—Lamps
2829 T. Henderson—Sewing machines
2830 J. Jackson — Lowering and letting go ships' anchors
2831 W. S. Ashton and J. Johnson—Preparing and spinning cotton
2832 E. Tavernier, H. W. Whitehead—Combing cotton and other fibres
2833 J. Becker—Stoppering bottles
2834 H. R. J. Denton—Bending chain links
2835 M. Pollack—Packing needles
2836 O. Rowland—Galvanic batteries
2837 W. Geeves—Saw mills
2838 J. Dens and R. C Rapier—Apparatus relating to railway switches, &c.

Dated November 2nd, 1866.

2839 H. Greaves—Unloading and delivery of coal, &c., from ships and other vessels
2840 T. Chatwin—Screw stocks and tube cutters
2841 G. Watson—Reflectors and ventilators
2842 S Holman—Pumps and pump vessels
2843 W. Frost, J. H. Leather, and J. Nelson—Auxiliary smith s fire
2844 R. Porter—Manufacture of gloves
2845 J. Howell—Hay and chaff cutting machines

Dated November 3rd, 1866.

2846 O. C. Edwards—Washing casks
2847 J. Harris— Production, distillation, and refining of hydrocarbon and other oils from shale and other bituminous minerals
2848 F. A. Calvert—Improvements in heating
2849 J. G. Tatters—Intercommunication between the several parts of railway trains
2850 R. J. Gay—Composition for coating walls
2851 J. Roberts—Artificial fuel
2852 E. Tonks—Call bells
2853 E. P North—Folding reading desk
2854 R. McTaggart and J. Holdforth—Pill making machine
2855 J. Lewis—Firearms and cartridges
2856 J. Chubb and W. H. Chalk—Iron safes and strong rooms
2857 J. Player—Lining for puddling furnaces
2858 F. Claudet—Treating waste solutions obtained from burnt cupreous pyrites
2859 W. Bayliss—Manufacture of anchors
2860 W. F. Phillipson—Bedsteads
2861 M. Chamberlain—Brushes
2862 J. S. Gisborne—Automatic means and apparatus to give warning of the dangerous existence of fire in warehouses and other places
2863 J. S. Gisborne—Compasses

Dated November 5th, 1866.

2864 H. Medd—Mounts for cartes de visite and playing cards
2865 T. D. Clapham—Means for producing figured woollen fabrics or other fabrics capable of being figured
2866 C. E. Brooman—Puddling, and apparatus employed therefor
2867 R. A. Hardcastle—Transmitting and controlling motion
2868 P. Kerr—Polishing threads and yarns
2869 M. de Briges—Obtaining photographic pictures

Dated November 6th, 1866.

2870 T. Walker—Electric telegraph cables, lines, and transmitting instruments connected therewith
2871 J. R. Wigham—Illuminating lighthouses, &c. and apparatus and gas burners employed for that purpose
2872 A. Grote—Printing textile fabrics
2873 N. F. Taylor—Means for operating on air by hydrocarbons for purposes of illumination
2874 J. H. Johnson—Rolling metals and machinery employed therein
2875 W. J. Matthews—Breech loading firearms
2876 E. H Bentall—Manufacturing screw nuts
2877 W. E. Newton—Poles for curtains and hangings
2878 T. Hunt—Breech loading firearms
2879 W. H. Clapp—Carriage brakes
2880 C. E. Spagnoletti—Arranging and combining apparatus for communicating between the guard, engine driver, and passengers in a railway train
2881 R. D. Napier—Friction breaks, and giving motion to machinery
2882 T. H. Ince—Firearms
2883 C. J. Robinson—Pump valves, &c.

Dated November 7th, 1866.

2884 W. Bracewell, W. Pickup, and B. Lund—Valves for engines worked by steam or other fluids
2885 E. Huxley—Coverlets, quilts, &c.
2886 W. Darlow and P. W. Seymour—Magnetic compound
2887 W. Humphrey—Furnaces for steam boilers
2888 J. Shaw—Preparing and spinning machinery
2889 W. E. Gedge—Apparatus fitting within every part of chimney
2890 J. Combe—Spinning fibrous substances
2891 T. Dawson and G. Paley—Sheathing vessels
2892 J. C. Newey—Clasps for stays, &c.
2893 J. Deavin, J. H. Sutton, and M. Deavin—Closing and keeping open doors and gates at any distance in lieu of using springs, &c.
2894 W. Goodbrand and T. E. Holland—Rendering the security of safes, &c., more effectual
2895 P. Kirk—Rolling metals
2896 J. E. Brown—Finishing woven fabrics and the machinery employed
2897 J. S. Cavell—Construction of automaton toys
2898 G. Haseltine—Brake for railway carriages
2899 C. Churchill—Chuck for holding drills and other tools
2900 G. Haseltine—Producing pictures, &c.
2901 C. Sutton—Toy to be actuated by steam
2902 E S. Hindley—Slide valves, &c.
2903 A V. Newton—Reaping machines
2904 W. E. Newton — Cleaning the exterior of houses, &c.

Dated November 8th, 1866.

2905 T. Kershaw—Improvements in that portion of a loom employed in taking up the cloth
2906 J. K. Heywood—Machinery and cutters for making bungs and taps
2907 J. J. Bagshawe—Furnaces for burning smoke
2908 J. Thomson—Gas stoves for heating and cooking
2909 G. Shaw—Manufacture of coke
2910 W. E. Gedge—Preserving the banks of rivers and watercourses, and other embankments from corrosion or wast
2911 R. J. Edwards—[illegible] preparing woven fabrics, &c.
2912 J. S. Cooke—Axle boxes
2913 A. Giles and T. Sturgeon—Drying wool, grain, and other substances
2914 T. Horsley and G. Knighton—Core bars or barrels

Dated November 9th, 1866.

2915 J. T. Kershaw—Improved ventilator
2916 C. D. Norton—Making revolving boots and shoe heels
2917 E. K Hesps—Cooking ranges

CMEASURES

05—1	·8237932—1	·8736211—1	·9171958—1	·9207028—1	·9470324—1	·9507286—1	·9760294—1	1

S.

TABLE I.—*Measures of Length.*

CE.—1 mètre = 10 décimètres = 100 centimètres
= 1-10,000,000th part of the earth's quadrant, m
orth Pole to the Equator.—Legal in France, Belg
ies, Italy, Spain, Portugal, Greece, Denmark, and
a AmericanStates.*

JGAL.—2 pié = $1\frac{1}{2}$ palmos = 12 pollegadas = 14
atos.—1 braça = 2 varas = $3\frac{1}{3}$ covados = $6\frac{2}{3}$
upplanted in Portugal by the metrical system; sti
d Portuguese Colonies.

—1 pied du Roi = 12 pouces = 144 lignes; 1
Roi.—Obsolete in France, but still used for
scientific purposes in general throughout the Co

IA.—1 Wiener fuss (foot) = 12 zoll = 144 li
om)=6 ft.—1 elle=2·455 ft.—1 ruthe= $1\frac{2}{3}$ klafte

A.—1 Rheinischer fuss (foot) = 12 zoll = 144 li
uss.—1 lachter = 6ft. 8in.—1 elle = $25\frac{1}{2}$ zoll:
varions minor States of Germany, formerly in D

ND.—1ft. = 12in.—1 chain = 66ft.= 100 links.—
6ft., &c. Legal in the United Kingdom and
o in Russia and the United States.

ERLAND.—1 fuss = 10 zoll = 100 linien = 0·30
ellen = 10 fuss.—1 stab = 4 fuss.—1 klafter =
tzerland and the Grand Duchy of Baden.

N.—1 fod = 10 fum = 100 linies.—1 staug =
nn (fathom) = 6 fod.

A.—1 fuss = 12 zoll = 144 linien.—1 ruthe =
fuss 123 linien.

—1 piê = $1\frac{1}{3}$ palmo = 12 pulgadas = 16 dedo
puntos.—1 estabal = 2 brassas = 4 varas =
$3\frac{1}{4}$ varas = $24\frac{3}{4}$ pies = 33 palmos.—Supplanted
al system; still in use in Spanish colonies an
ublics.

observation applies to *all* these eight tables.

, U.S., &c.) 1lb. = 16 oz. =
arters = 160 stones = 2,240lbs.
uutz = 32 lods = 128 qwintin
= 400 skalpund.
as = 32 loths = 96 zolotniks
s = 30 pood = 1,200 funt.
&c.)—1lb. = 12oz. = 96 drams
rains.
.—The Customs' weight (*Zoll-*.
gramme, is the legal weight in
Switzerland, aud has receutly
Denmark. Its divisions are:
nt.—1 cwt. (zollzentner) = 100

res of Capacity.

SURES.
1-18th Swiss cubic ft.—1 viertel

el = 8 pfiff = ·0448 Austrian

= 16 jungfrurs = 50 Swedish
oxhufundens = 6 ams = 24

kas = $12\frac{1}{2}$ tsharkas = 74·0568.
es = $13\frac{1}{3}$ ankers = 40 vedros =

ish cubic inches.—1 fuder = 4
nker = 720 quart.
ts = 8 pints = 32 gills.—1 Im-
es, holding 10lbs. a.d.p. of dis-
perature of 62° F., the barometer
= 2 hogsheads = 4 barrels = 7
ns.
ne) = 4 quartel = 8 achtel =
= 60 maas.

8.—HANOVER.—1 quart = 2 nössel = 135 Hanover. cubic inches = 118·81836 English cubic inches. (1 Hanover foot = $11\frac{1}{2}$ English ins.)—1 ohm = 4 anker = 40 stübchen = 80 kannen = 16 qt.

9. FRANCE, ITALY, &c.—1 litre = 10 décilitres = 100 centilitres = 1,000 millilitres = 1 cubic decimètre.—1 hectolitre = 100 litres.

10.—UNITED STATES, CANADA, &c.—Same subdivisions as England. 1 gallon = 231 cubic inches, weighing 8·3388822lbs. a.d.p.

DRY MEASURES.

1.—SWITZERLAND.—Concordatmasse, according to Act of Federal Assembly of December 23, 1851. 1 malter = 10 vierteln = 40 vierling = 16 mässlein.—1 mässleim = 1 maas.*

2.—AUSTRIA.—1 muth = 30 metzen = 480 maassel = 1,920 futtermaassel = 3,840 becher = 58·413 Austrian cubic feet.

3.—SWEDEN.—1 tonne = 2 spans = 8 pjerdings = 32 kappre = 56 kannas* = 112 stops.*

4.—RUSSIA.—1 tshetwert = 2 osmins = 4 pajacks = 8 tshetverik = 32 tshetverka = 64 garnetz = 12,809·696 cubic inches.

5.—PRUSSIA.—1 winspel = 2 malter = 24 scheffeln = 96 vierteln = 284 metzen.—1 scheffel = 3072 Rhenish cubic inches.

6.—ENGLAND.—1 bushel = 4 pecks = 8 gallons* = 16 pottles = 32 quarts* = 64 pints.*

7.—BAVARIA.—1 scheffel = 6 metzen = 12 viertel = 48 maassel = 192 dreissiger.—1 metze = $34\frac{2}{3}$ maas.*

8.—HANOVER.—1 last = 16 malter = 96 himten = 384 metzen.—1 himten = $1\frac{1}{4}$ Hanover cubic foot.

9.—FRANCE, ITALY, &c.—1 hectolitre* = 100 litres.*

10.—UNITES STATES, CANADA.—1 barrel = $4\frac{1}{2}$ bushel = 18 pecks = 36 gallons* = 9676·890 cubic inches.

N.B. SPAIN, PORTUGAL, &c.—Old measures vary in the different provinces; uew measures as in France.

* Dry measures identical with liquid measures.

"THE ARTIZAN" TABLES

OF EQUIVALENTS AND THEIR LOGARITHMS, FOR THE

CONVERSION OF WEIGHTS AND MEASURES

OF VARIOUS COUNTRIES.

By JOSEPH T. DANN.

I.—MEASURES OF LENGTH.

French Mètre.	Portugal Foot.	Paris Foot.	Austrian Foot.	Rhenish Foot.	English Foot.	Swiss Foot.	Swedish Foot.	Bavarian Foot.	Spanish Foot.
1	3·066841 ·4866910	3·073444 ·4883018	3·162543 ·5000334	3·186205 ·5032737	3·280899 ·5159930	3·333410 ·5228787	3·368111 ·5273804	3·420293 ·5340245	3·588945 ·5549568
·326087 ·5133090−1	1	1·003779 ·0016381	1·031206 ·0133454	1·038918 ·0165813	1·069800 ·0293026	1·086895 ·0361877	1·098235 ·0406953	1·117007 ·0481335	1·170243 ·0682758
·324841 ·5116709−1	·996235 ·9983619−1	1	1·027324 ·0117073	1·035007 ·0149432	1·065773 ·0276645	1·082803 ·0345496	1·094101 ·0390572	1·113001 ·0464954	1·165836 ·0666377
·316201 ·4999636−1	·969738 ·9866546−1	·973400 ·9882927−1	1	1·007479 ·0032350	1·037426 ·0159572	1·054004 ·0228423	1·065001 ·0273499	1·083398 ·0347881	1·134839 ·0549304
·313854 ·4967277−1	·962540 ·9834167−1	·966177 ·9850568−1	·992805 ·9968641−1	1	1·029725 ·0127213	1·046180 ·0196064	1·057825 ·0244140	1·075356 ·0315522	1·126405 ·0516045
·304794 ·4840064−1	·934754 ·9706974−1	·938287 ·9723355−1	·964146 ·9850428−1	·971133 ·9872787−1	1	1·015960 ·0068851	1·026570 ·0113927	1·044314 ·0188300	1·093890 ·0389732
·300000 ·4771213−1	·920052 ·9638123−1	·923529 ·9654504−1	·949763 ·9771577−1	·955859 ·9803930−1	·984272 ·9931119−1	1	1·010433 ·0045070	1·027683 ·0119458	1·076684 ·0320881
·296903 ·4726137−1	·910552 ·9593047−1	·913993 ·9609428−1	·938967 ·9726501−1	·945989 ·9758860−1	·974108 ·9886073−1	·989675 ·9954924−1	1	1·017275 ·0074382	1·065666 ·0275805
·291861 ·4651755−1	·895090 ·9518665−1	·898472 ·9535040−1	·923022 ·9652119−1	·929925 ·9684178−1	·957567 ·9811691−1	·972869 ·9880542−1	·983019 ·9925618−1	1	1·047472 ·0201423
·278633 ·4450332−1	·854524 ·9317242−1	·857753 ·9333623−1	·881190 ·9450696−1	·887760 ·9483056−1	·914169 ·9610368−1	·928778 ·9679119−1	·938468 ·9724195−1	·954680 ·9798577−1	1

II.—ITINERARY MEASURES.

Swedish Mile.	Austrian Mile.	Prussian Mile.	German Mile.	Spanish Mile.	Swiss Mile.	Nautical Mile.	Statute Mile.	Russian Verst.	French Kilomètre.
1	1·406449 ·1481412	1·418953 ·1518768	1·442944 ·1592494	1·595346 ·2028707	2·226765 ·3476744	5·771774 ·7613093	6·641628 ·8222715	10·019387 1·0008403	10·688472 1·0289156
·710001 ·8512588−1	1	1·007478 ·0032359	1·024491 ·0105082	1·134827 ·0549295	1·581005 ·1989332	4·097963 ·6125631	4·715560 ·6735333	7·113788 ·8520201	7·588824 ·8801744
·704731 ·8480232−1	·992578 ·9967641−1	1	1·016887 ·0072720	1·126403 ·0516979	1·569270 ·1956976	4·067549 ·6093427	4·680559 ·6702977	7·060985 ·8488845	7·532496 ·8769388
·693028 ·8407566−1	·976094 ·9894918−1	·983394 ·9927271−1	1	1·107698 ·0444213	1·543210 ·1884250	4·000000 ·6020600	4·602832 ·6630251	6·943700 ·8415900	7·407407 ·8696662
·625647 ·7963293−1	·881192 ·9450705−1	·887781 ·9483061−1	·902773 ·9555787−1	1	1·393169 ·1440037	3·611093 ·5576386	4·155314 ·6186038	6·268586 ·7971690	6·687309 ·8252449
·449082 ·6523256−1	·632509 ·8010668−1	·637239 ·8043024−1	·648000 ·8115750−1	·717788 ·8559963−1	1	2·592000 ·4136350	2·982635 ·4746001	4·499516 ·6531650	4·800000 ·6812412
·173257 ·2386907−1	·244024 ·3874319−1	·245848 ·3906675−1	·250000 ·3979401−1	·276924 ·4423614−1	·385803 ·5863651−1	1	1·150700 ·0609652	1·735925 ·2395310	1·851852 ·2676063
·150566 ·1777255−1	·212064 ·3264667−1	·213650 ·3297023−1	·217258 ·3369749−1	·240656 ·3813962−1	·335274 ·5253999−1	·869030 ·9390348−1	1	1·508571 ·1785658	1·609315 ·2066411
·0998067 ·9991597−2	·140573 ·1479009−1	·141624 ·1511365−1	·144015 ·1584091−1	·159526 ·2028301−1	·222246 ·3468341−1	·576062 ·7604690−1	·662879 ·8214342−1	1	1·066781 ·0280753
·0935587 ·9710844−2	·131773 ·1198256−1	·132758 ·1230612−1	·135000 ·1303338−1	·149539 ·1747551−1	·208333 ·3187588−1	·540000 ·7323938−1	·621382 ·7933589−1	·937400 ·9719247−1	1

III.—SQUARE MEASURES.

French Square Mètre.	Portugal Square Foot.	Paris Square Foot.	Austrian Square Foot.	Rhenish Square Foot.	English Square Foot.	Swiss Square Foot.	Swedish Square Foot.	Bavarian Square Foot.	Spanish Square Foot.
1	9·405503 ·9733820	9·476890 ·9766026	10·001631 1·0000728	10·151902 1·0065471	10·764305 1·0319860	11·111111 1·0457574	11·344173 1·0547728	11·739484 1·0696490	12·880524 1·1099336
·106321 ·0266180−1	1	1·007572 ·0032762	1·063386 ·0266908	1·079351 ·0331626	1·144472 ·0586052	1·181341 ·0723754	1·206190 ·0813906	1·248150 ·0962670	1·369467 ·1365516
·105522 ·0233418−1	·992485 ·9967238−1	1	1·055304 ·0234146	1·071239 ·0298864	1·135871 ·0553290	1·172463 ·0690992	1·197056 ·0781144	1·238771 ·0929908	1·359175 ·1332754
·0999832 ·9999272−2	·940393 ·9732092−1	·947514 ·9765854−1	1	1·015014 ·0064718	1·076253 ·0319144	1·110925 ·0456846	1·134227 ·0546998	1·173753 ·0695762	1·287837 ·1098608
·0985043 ·9934554−2	·926483 ·9668374−1	·933499 ·9701136−1	·985663 ·9937282−1	1	1·060334 ·0254426	1·094493 ·0392128	1·117450 ·0482280	1·156390 ·0631044	1·268788 ·1033890
·0929004 ·9680128−2	·873765 ·9413948−1	·880382 ·9446710−1	·929536 ·9682856−1	·943100 ·9745574−1	1	1·032215 ·0137702	1·053866 ·0227854	1·090591 ·0376618	1·196594 ·0779464
·0900000 ·9542426−2	·846495 ·9276216−1	·852905 ·9309008−1	·900181 ·9543154−1	·913665 ·9607872−1	·968791 ·9862298−1	1	1·020975 ·0090152	1·056554 ·0238916	1·159248 ·0641762
·0881510 ·9452274−2	·829105 ·9186094−1	·835383 ·9218856−1	·881658 ·9453002−1	·894895 ·9517720−1	·948887 ·9772146−1	·979456 ·9909848−1	1	1·034846 ·0148764	1·135432 ·0551610
·0851826 ·9303510−2	·801185 ·9037330−1	·807252 ·9070092−1	·851969 ·9304238−1	·864760 ·9368956−1	·916934 ·9623382−1	·946473 ·9761084−1	·966326 ·9851236−1	1	1·097197 ·0402846
·0776366 ·8900684−2	·730211 ·8634484−1	·735740 ·8667240−1	·776496 ·8901392−1	·788154 ·8966110−1	·835706 ·9220536−1	·862626 ·9358238−1	·880722 ·9448390−1	·911413 ·9597154−1	1

IV.—CUBIC MEASURES.

French Cubic Mètre.	Portugal Cubic Foot.	Paris Cubic Foot.	Austrian Cubic Foot.	Rhenish Cubic Foot.	English Cubic Foot.	Swiss Cubic Foot.	Swedish Cubic Foot.	Bavarian Cubic Foot.	Spanish Cubic Foot.
1	28·845166 1·4600730	29·173661 1·4649130	31·030729 1·5001092	32·346038 1·5098211	35·316508 1·5479790	37·037037 1·5686361	38·208424 1·5821592	40·232909 1·6044735	46·227711 1·6649004
·0346679 ·5399270−2	1	1·011380 ·0049143	1·069570 ·0400392	1·121357 ·0497430	1·224356 ·0879078	1·283994 ·1085631	1·324603 ·1220850	1·394442 ·1444005	1·602609 ·2048274
·0342778 ·5350127−2	·988748 ·9950857−1	1	1·084231 ·0351219	1·108740 ·0448290	1·210530 ·0829935	1·269547 ·1036488	1·309699 ·1171716	1·378752 ·1394862	1·584576 ·1999131
·0316148 ·4998008−2	·911935 ·9599638−1	·922313 ·9648781−1	1	1·022604 ·0097077	1·116533 ·0478710	1·170919 ·0685269	1·207952 ·0820497	1·271640 ·1043643	1·461474 ·1647912
·0309160 ·4901831−2	·891777 ·9502561−1	·901925 ·9551704−1	·978571 ·9906923−1	1	1·091852 ·0381639	1·145036 ·0588192	1·181251 ·0723420	1·243531 ·0946566	1·429160 ·1550835
·0283152 ·4520192−2	·816750 ·9120922−1	·826050 ·9170065−1	·901838 ·9551284−1	·915875 ·9618361−1	1	1·048710 ·0206553	1·081877 ·0341781	1·138910 ·0564927	1·308940 ·1169196
·0270000 ·4313639−2	·778819 ·8914369−1	·787683 ·8963512−1	·854030 ·9314731−1	·873335 ·9411803−1	·953553 ·9793447−1	1	1·031627 ·0135228	1·086019 ·0358371	1·248143 ·0962643
·0261723 ·4178411−2	·754943 ·8779141−1	·763534 ·8828284−1	·827847 ·9179503−1	·846501 ·9276580−1	·924319 ·9658219−1	·969342 ·9864772−1	1	1·052724 ·0223146	1·209872 ·0827415
·0248615 ·3955265−2	·717133 ·8555995−1	·725294 ·8605138−1	·786386 ·8956357−1	·804162 ·9053434−1	·878026 ·9435073−1	·920794 ·9641626−1	·949910 ·9776854−1	1	1·149282 ·0604269
·0216321 ·3350096−2	·623963 ·7951726−1	·631064 ·8000869−1	·684241 ·8352088−1	·699707 ·8449165−1	·763977 ·8830804−1	·801190 ·9037357−1	·826530 ·9172585−1	·870106 ·9395731−1	1

V.—MEASURES OF SUPERFICIES (Acres).

Russian Dessatine.	French Hectare.	Spanish Fanegada.	Austrian Joch.	Portugal Geira.	Swedish Tunland.	English Acre.	Swiss Jachart.	Bavarian Morgen.	Prussian Morgen.
1	1·092509 ·0384249	1·693951 ·2289008	1·897034 ·2780752	1·910535 ·2811549	2·213104 ·3450018	2·699745 ·4313227	3·034748 ·4821223	3·200359 ·5050129	4·278936 ·6313347
[illegible]5325 ·9615752−1	1	1·550515 ·1904760	1·736402 ·2396504	1·748760 ·2427301	2·025703 ·3065770	2·471145 ·3928979	2·777778 ·4436975	2·934860 ·4675871	3·918596 ·5929100
·590336 ·7710092−1	·643947 ·8095240−1	1	1·119887 ·0491744	1·127857 ·0522541	1·306475 ·1161010	1·593755 ·2024219	1·791523 ·2532225	1·892821 ·2771111	2·526003 ·4024339
·527139 ·7219248−1	·575036 ·7603406−1	·892947 ·9508250−1	1	1·030570 ·0030777	1·166612 ·0669266	1·423140 ·1532475	1·599731 ·2040471	1·690196 ·2279370	2·255586 ·3532595
·523414 ·7188451−1	·571834 ·7572609−1	·886637 ·9477450−1	·992934 ·9969203−1	1	1·158369 ·0638469	1·413083 ·1501678	1·588427 ·2009674	1·678252 ·2248573	2·239648 ·3501798
·451854 ·6549982−1	·493654 ·6934230−1	·765419 ·8838990−1	·857183 ·9330734−1	·863283 ·9361531−1	1	1·219891 ·0863209	1·371262 ·1371205	1·448807 ·1610104	1·933450 ·2863329
·370405 ·5686773−1	·404071 ·6071021−1	·627449 ·7975781−1	·702660 ·8467525−1	·707672 ·8498322−1	·870742 ·9130791−1	1	1·124086 ·0507990	1·187626 ·0747895	1·584937 ·2000120
·329517 ·5178777−1	·360000 ·5563025−1	·558185 ·7467785−1	·625105 ·7959529−1	·629553 ·7990326−1	·729255 ·8628705−1	·889611 ·9492004−1	1	1·056550 ·0238899	1·409978 ·1492124
·311880 ·4939878−1	·340732 ·5324126−1	·528310 ·7228886−1	·591547 ·7720630−1	·595858 ·7751427−1	·690223 ·8389806−1	·841997 ·9253105−1	·946477 ·9761101−1	1	1·334512 ·1253225
·233704 ·3686653−1	·255323 ·4070901−1	·395682 ·5975661−1	·443344 ·6467407−1	·446499 ·6498202−1	·517210 ·7136671−1	·630928 ·7999880−1	·709231 ·8507876−1	·749338 ·8746775	1

VI.—MEASURES OF SUPERFICIES (Square Miles).

Swedish Square Mile.	Austrian Square Mile.	Prussian Square Mile.	German Square Mile.	Spanish Square Mile.	Swiss Square Mile.	Nautical Square Mile.	Statute Square Mile.	Russian Square Verst.	French Square Kilomètre.
1	1·983775 ·2974824	2·013509 ·3039536	2·062087 ·3184088	9·554700 ·4073411	4·058482 ·6063489	33·313370 1·5226186	44·111210 1·6445100	100·387723 2·0016806	114·243421 2·0578312
·504101 ·7025170−1	1	1·015012 ·0064712	1·049582 ·0210101	1·287832 ·1098590	2·499518 ·3978664	16·793308 1·2251362	22·236505 1·3470660	50·605558 1·7041982	57·590227 1·7603488
·496645 ·6960104−1	·985210 ·9935288−1	1	1·034059 ·0145452	1·268755 ·1033878	2·462607 ·3913952	16·544540 1·2186650	21·907631 1·3407954	49·857100 1·6977270	58·738465 1·7538776
·480287 ·6815012−1	·952760 ·9789836−1	·967063 ·9854548−1	1	1·226994 ·0888426	2·381497 ·3768500	16·000000 1·2041198	21·186060 1·3260502	48·214955 1·6831818	54·869675 1·7393324
·391434 ·5926586−1	·776499 ·8901410−1	·788156 ·8966122−1	·815000 ·9111574−1	1	1·940919 ·2880074	13·039934 1·1152772	17·266632 1·2372076	39·295173 1·5943392	44·718762 1·6504898
·201675 ·3046512−1	·400068 ·6021336−1	·406074 ·6086048−1	·419904 ·6231500−1	·515220 ·7119926−1	1	6·718462 ·8272698	8·896110 ·9492002	20·245656 1·3063318	23·640000 1·3736824
·0238441 ·4773814−2	·0595475 ·7748038−2	·0604415 ·7813350−2	·0625000 ·7958800−2	·0766872 ·8847228−2	·148844 ·1727302−1	1	1·324120 ·1219304	3·013435 ·4790620	3·420356 ·5352126
·0226797 ·3554510−2	·0449711 ·6529334−2	·0458462 ·6594046−2	·0472008 ·6739498−2	·0578152 ·7627924−2	·112409 ·0507098−1	·755213 ·8780696−1	1	2·275787 ·3571316	2·589895 ·4132822
·00996138 ·9983194−3	·0181507 ·2958018−2	·0200573 ·3022730−2	·0207404 ·3168182−2	·0255659 ·4076608−2	·0493933 ·6936682−2	·331847 ·5209350−1	·439408 ·6428684−1	1	1·138023 ·0561506
·00875324 ·9421088−3	·0173641 ·2396512−2	·0176247 ·2461224−2	·0182250 ·2606676−2	·0223620 ·3495102−2	·0434023 ·6375176−2	·293272 ·4017871−1	·389110 ·5867178−1	·878718 ·9438494−1	1

VII.—WEIGHTS.

French Kilogramme.	Austrian Pound.	Danish Pound.	Prussian Pound.	Spanish Pound.	Portugal Pound.	Avoirdupois Pound.	Swedish Pound.	Russian Pound.	Troy Pound.
1	1·785676 ·2518027	2·002706 ·3016306	2·138113 ·3300307	2·173480 ·3371553	2·179030 ·3382621	2·204610 ·3433339	2·351060 ·3712648	2·441007 ·3877291	2·679227 ·4280095
·560012 ·7481973−1	1	1·124159 ·0508279	1·197369 ·0782280	1·217174 ·0853526	1·220280 ·0864594	1·234613 ·0915309	1·316625 ·1194621	1·370650 ·1369264	1·500399 ·1762068
·499309 ·6983694−1	·891604 ·9501721−1	1	1·067579 ·0284001	1·085237 ·0355247	1·088006 ·0366315	1·100780 ·0417030	1·173908 ·0696342	1·191513 ·0760985	1·337762 ·1263789
·467702 ·6699693−1	·835357 ·9218720−1	·936690 ·9716099−1	1	1·016540 ·0071246	1·019134 ·0082311	1·031105 ·0133029	1·099598 ·0412341	1·142085 ·0576984	1·253060 ·0979768
·460093 ·6628447−1	·821575 ·9146474−1	·921457 ·9644753−1	·983729 ·9928754−1	1	1·002552 ·0011068	1·014328 ·0061783	1·081707 ·0341095	1·123502 ·0505738	1·233690 ·0908512
·458921 ·6617379−1	·819484 ·9135406−1	·919112 ·9633685−1	·981225 ·9917686−1	·997684 ·9989932−1	1	1·011746 ·0050715	1·078953 ·0330027	1·120642 ·0494670	1·229553 ·0897471
·453593 ·6566661−1	·809970 ·9084691−1	·908442 ·9582970−1	·969833 ·9866971−1	·985875 ·9938217−1	·988391 ·9949285−1	1	1·066427 ·0279312	1·107632 ·0443955	1·215280 ·0846756
·425339 ·6287352−1	·759518 ·8805379−1	·851855 ·9303658−1	·909423 ·9587659−1	·924465 ·9658905−1	·926824 ·9669973−1	·937711 ·9720688−1	1	1·038638 ·0164643	1·139580 ·0567447
·409516 ·6122709−1	·731263 ·8640736−1	·820105 ·9139015−1	·875592 ·9423016−1	·890074 ·9494262−1	·892345 ·9505330−1	·902827 ·9556045−1	·962799 ·9835357−1	1	1·097186 ·0402804
·373242 [illegible]05−1	·666489 ·8237932−1	·747517 ·8736211−1	·798034 ·9020212−1	·811233 ·9091458−1	·813303 ·9102526−1	·822856 ·9153241−1	·877517 ·9432553−1	·911422 ·9597196−1	1

VIII.—MEASURES OF CAPACITY.

Swiss Maas.	Austrian Maas.	Swedish Stop.	Russian Osloff.	Prussian Quart.	Imperial Quart.	Bavarian Maas.	Hanover Quart.	French Litre.	United States Quart.
1	1·059956 ·0252878	1·146244 ·0592773	1·219615 ·0862229	1·609958 ·2172567	1·320577 ·1207637	1·403115 ·1470933	1·415108 ·1507615	1·500000 ·1760913	1·585115 ·2000609
·943435 ·0747122−1	1	1·056790 ·0239885	1·150628 ·0609351	1·235831 ·0919689	1·245878 ·0954759	1·323748 ·1218055	1·335063 ·1255017	1·415015 ·1508025	1·495454 ·1747731
·812414 ·9107227−1	·946263 ·9760115−1	1	1·054010 ·0200456	1·142824 ·0579794	1·152090 ·0614861	1·224098 ·0878160	1·234560 ·0915125	1·308618 ·1168130	1·382877 ·1407830
·819931 ·9137771−1	·869090 ·9390649−1	·939841 ·9730544−1	1	1·074073 ·0310338	1·082782 ·0345408	1·150457 ·0608701	1·160287 ·0645650	1·229893 ·0898671	1·299685 ·1138380
·753384 ·8827433−1	·809154 ·9080311−1	·875025 ·9420206−1	·931035 ·9689662−1	1	1·008108 ·0035070	1·071118 ·0298369	1·080271 ·0335328	1·145074 ·0588330	1·210052 ·0828042
·757245 ·8792363−1	·802646 ·9045241−1	·807988 ·9385136−1	·923547 ·9654592−2	·992180 ·9965930−1	1	1·062502 ·0263296	1·071583 ·0300258	1·135884 ·0553260	1·200597 ·0793972
·712700 ·8529067−1	·755431 ·8781945−1	·816929 ·9121840−1	·869220 ·9391296−1	·933605 ·9701634−1	·941175 ·9736704−1	1	1·008547 ·0036962	1·069047 ·0289870	1·129712 ·0529676
·706660 ·8492105−1	·749028 ·8744983−1	·810005 ·9084878−1	·861855 ·9354341−1	·925693 ·9664672−1	·933199 ·9699742−1	·991525 ·9963038−1	1	1·059986 ·0253008	1·120137 ·0492714
·666667 ·8239087−1	·706639 ·8491975−1	·764185 ·8831870−1	·813079 ·9101326−1	·873306 ·9411664−1	·880397 ·9446734−1	·935412 ·9710030−1	·943407 ·9746992−1	1	1·056746 ·0239706
·630860 ·7999391−1	·668693 ·8252280−1	·723130 ·8592164−1	·769417 ·8861620−1	·826410 ·9171958−1	·833111 ·9207028−1	·885182 ·9470324−1	·892747 ·9507286−1	·946301 ·9760294−1	1

MULTIPLES SUBDIVISIONS AND EXPLANATIONS.

Table I.—Measures of Length. [illegible]

Table II.—Itinerary Measures. [illegible]

Table III.—Square Measures. The subdivisions, &c., are the squares of those of Table I.

Table IV.—Cubic Measures. The subdivisions, &c., are the cubes of those of Table I.

Table V.—Measures of Superficies (Acres). [illegible]

Table VI.—Measures of Superficies (Square Miles). The subdivisions, &c., are the squares of those of Table II.

Table VII.—Weights. [illegible]

Table VIII.—Measures of Capacity. Liquid Measures. [illegible]

Dry Measures. [illegible]

† Observation applies to all three right tables.

* Dry measures identical with liquid measures.